MINISTRY OF MUNITIONS.

HEALTH OF MUNITION WORKERS COMMITTEE.

INTERIM REPORT.

INDUSTRIAL EFFICIENCY AND FATIGUE.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1;
37, PETER STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF;
23, FORTH STREET, EDINBURGH;
or from E. PONSONBY, LTD., 116, GRAFTON STREET, DUBLIN;
or from the Agencies in the British Colonies and Dependencies,
the United States of America and other Foreign Countries of
T. FISHER UNWIN, LTD., LONDON, W.C. 2.

1917.

[Cd. 8511.] *Price* 1*s.* 3*d. Net.*

MINISTRY OF MUNITIONS.

HEALTH OF MUNITION WORKERS COMMITTEE.

INTERIM REPORT.

INDUSTRIAL EFFICIENCY AND FATIGUE.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1;
37, PETER STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF;
23, FORTH STREET, EDINBURGH;
or from E. PONSONBY, LTD., 116, GRAFTON STREET, DUBLIN;
or from the Agencies in the British Colonies and Dependencies,
the United States of America and other Foreign Countries of
T. FISHER UNWIN, LTD., LONDON, W.C. 2.

1917.

[Cd. 8511.] *Price* 1*s.* 3*d. Net.*

HEALTH OF MUNITION WORKERS COMMITTEE.

The Committee were appointed by the Minister of Munitions, with the concurrence of the Home Secretary, "To consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munitions factories and workshops."

The members of the Committee are:—

Sir GEORGE NEWMAN, M.D. (Chairman).
Sir THOMAS BARLOW, Bart., K.C.V.O., M.D., F.R.S.
G. BELLHOUSE, Factory Department, Home Office.
Professor A. E. BOYCOTT, M.D., F.R.S.
J. R. CLYNES, M.P.
E. L. COLLIS, M.B., Factory Department, Home Office.
W. M. FLETCHER, M.D., F.R.S., Secretary of Medical Research Committee.
LEONARD E. HILL, M.B., F.R.S.
SAMUEL OSBORN, J.P., Sheffield.
Miss R. E. SQUIRE, Factory Department, Home Office.
Mrs. H. J. TENNANT.

E. H. PELHAM (Secretary).

The following Memoranda have been prepared by the Committitee:—

No. 1.—Sunday Labour.
No. 2.—Welfare Supervision.
No. 3.—Industrial Canteens.
No. 4.—Employment of Women.
No. 5.—Hours of Work.
No. 6.—Canteen Construction and Equipment (Appendix to No. 3).
No. 7.—Industrial Fatigue and its Causes.
No. 8.—Special Industrial Diseases.
No. 9.—Ventilation and Lighting of Munition Factories and Workshops.
No. 10.—Sickness and Injury.
No. 11.—Investigation of Workers' Food and Suggestions as to Dietary. (Report by Leonard E. Hill, F.R.S.)
No. 12.—Statistical Information concerning Output in relation to Hours of Work. (Report by H. M. Vernon, M.D.)
No. 13.—Juvenile Employment.
No. 14.—Washing Facilities and Baths.
No. 15.—The Effect of Industrial Conditions upon Eyesight.
No. 16.—Medical Certificates for Munition Workers.
No. 17.—Health and Welfare of Munition Workers outside the Factory.

(B 9066) Wt. 56590—3502 8M 4/17 H & S

MINISTRY OF MUNITIONS.

Health of Munition Workers Committee.

INTERIM REPORT.

INDUSTRIAL EFFICIENCY AND FATIGUE.

To the Right Hon. CHRISTOPHER ADDISON, M.D., M.P.,
Minister of Munitions.

SIR,

1. In view of the immediate urgency of many of the problems which they were called upon to investigate, the Committee decided at an early stage of their inquiries to issue a series of Memoranda on various questions rather than to defer reporting until their inquiries had been completed. In accordance with this arrangement, seventeen Memoranda have been prepared. The present interim report contains the results of some of the investigations which have been made on behalf of the Committee into certain problems affecting output, lost time, sickness and other similar matters, which are of practical importance at the present time. The Committee in their Memorandum No. 7, "Industrial Fatigue and its Causes," drew attention to the importance of accurate measurement of these factors in any endeavour to ascertain the existence of fatigue. In the course of their inquiries the Committee have taken evidence from employers, workers and other persons from all parts of the country whose experience and knowledge entitle them to speak with authority on industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of munition workers. These witnesses, however, with hardly an exception, have been unable to point to any exact data in support or in disproof of their particular views. That such data should not be forthcoming in regard to the exceptional conditions at present obtaining is, perhaps, hardly a cause of surprise, but it is a matter of remark that there should in the past have been such a complete absence of all systematic effort on the part either of official bodies or of individual firms to collect exact data which might prove of permanent value in the solution of industrial problems. With a few exceptions, leaders of industry have made no systematic endeavour to discover by any method other than that of preconceived opinion (*a*) what is the best length for the working day; (*b*) what is the most economical arrangement for spells of work; (*c*) what are the real causes of lost time; and (*d*) what are the health requirements which are essential to a proper industrial organisation. The firms who have made successful pioneer experiments have had few imitators, despite the success of some of the reforms which they have introduced.

2. The Committee have from the first considered it to be one of their principal duties to endeavour to obtain such data, and for this purpose have called to their assistance a number of special investigators. For the more directly industrial and statistical parts of these inquiries they have secured, with the help of the Medical Research Committee, the services of Mr. P. Sargant Florence, Mr. H. M. Vernon, M.D., Fellow of Magdalen College, Oxford (with whom has been associated Mr. W. Neilson Jones), Professor Thomas Loveday, Armstrong College, University of Durham, and Captain M. Greenwood, R.A.M.C. (with whom has been associated Mr. S. H. Burchell). Medical inquiries into the health of male workers have been undertaken by Captain T. H. Agnew, R.A.M.C., while the medical examinations of women workers have been undertaken by Miss Janet Campbell, M.D., M.S., and Miss Lilian Wilson, M.D. (Medical Officers of the Board of Education), with the help of

some other women medical practitioners, and also of various Inspectors of Government Departments, who assisted in the collection of information in regard to the factory and social environment of the workers examined. The Committee are desirous of taking this opportunity of expressing their appreciation of the services rendered by their investigators, and of thanking the Government Departments concerned for their courtesy in granting permission for the employment of their officers.

The Committee are also under obligation to munition firms and their staffs for the readiness with which they have afforded the investigators every opportunity for pursuing their inquiries.

3. The abnormal conditions at present existing in munition works are favourable to investigation, in that they afford unusual opportunities of studying the effect of abnormal hours, of night work, and of other variations in the hours and conditions of employment. There has, too, been a general endeavour to relax trades union restrictions. Further, a large proportion of munition work consists in the more or less rapid repetition of particular processes, and thus readily lends itself to the calculation of rates of output. The circumstances, on the other hand, have been disadvantageous in that there have necessarily been frequent changes in the number of workers employed, in the conditions of employment and in the processes used, which have made it difficult to obtain data in regard to large numbers of workers or for long periods of time. The high pressure under which the management have generally been working has limited the number of firms who have found it practicable to keep records sufficiently accurate and complete to permit of trustworthy data being obtained from them. The Committee have sought to avoid any interference with the regular workings of the factories, and it has not yet been possible to arrange for control experiments; the statistical data examined have been those extracted from the wage sheets and other records kept by firms for their own purposes. By this method, however, the advantage has been gained that in no case were the workers aware that the records of their work were likely to be subjected to any unusual scrutiny. The conditions, in fact, were normal and not artificial; the inquiries were in the nature of " field " and not laboratory experiments, and the data gain in value accordingly.

4. The investigations of the Committee are still in progress, and it is hoped that they may be extended rather than restricted in the future. The information which has already been collected appears to the Committee to be of sufficient importance to merit publication, and it is presented in the present volume, which on grounds of economy has been kept within narrow limits. There has necessarily been some variation in the method of treatment. In some instances the data collected by a single investigator have been sufficiently complete to warrant the separate publication of the investigator's own report. In other instances the full relevance of the data collected by one investigator is only apparent when they are compared and correlated with data collected by other investigators; in such cases memoranda have been prepared, collating the data in regard to a particular subject and suggesting the conclusions which may fairly be drawn. The studies included in the present volume fall naturally into two parts—Part I, Industrial and Statistical Studies; Part II, Medical Studies. The data presented in the two parts differ in certain essential particulars. In the first part they are based on a study of ascertained facts; in the second part they are based upon opinions formed as the result of medical examinations and upon information supplied by the workers examined. It may be convenient shortly to summarise the principal matters to which reference is made.

Part I.—Industrial and Statistical Studies.

5. The Committee have thought it convenient to preface this section of studies by incorporating their Memorandum No. 7 on " Industrial Fatigue and its Causes," since in that Memorandum are discussed at length the causes of fatigue and the manner in which they should be measured and described. They have also included Dr. Vernon's study on " Output in relation to Hours of Work " (already published separately as Memorandum No. 12), in which he sets out various data collected by him to show the influence on output of varying hours of employment, and makes suggestions as to what may be expected to be the best hours of employment for men and women workers, having regard to the varying strain involved in their work. The three other studies are now published for the first time.

The Comparative Efficiency of Day Work and Night Work.—This study summarises data which have been collected by various investigators in regard to the effect upon output of employing men and women at night either on the discontinuous system (under which a worker is employed for weekly periods alternately by night and day) and under the continuous system (under which a worker is employed continuously at night for a long period). From a consideration of the data the Committee conclude that in the case of women the continuous night system is productive of substantially less output than is the discontinuous system. The timekeeping, too, of women and girls over or about 19 years of age working alternate weeks of day and night shifts appears to be even better maintained than when they worked on permanent day shifts. Further, there is no significant difference between the rate of output in night and day shifts managed on the discontinuous system. The Committee accordingly suggest that for women it is undesirable to adopt continuous night shifts in any factory not at present so working or not yet open, and that wherever practicable this system should be discontinued. Though the evidence in the case of men is not so pronounced the same conclusions apply generally.

The Causes and Conditions of Lost Time.—In this investigation Professor Loveday sets out material which he has collected in regard to the incidence and causation of lost time. The principal causes of lost time are described, and in particular is discussed the question of how far lost time is attributable to sickness; it is suggested that insufficient allowance is generally made for the extent to which lost time is caused by sickness, partly owing to the difficulty of obtaining reliable medical certificates. Methods of testing the accuracy of sickness records are considered. Except where hours have been very long relatively to the class of work, Professor Loveday is unable to find evidence of an increase of sickness notwithstanding the withdrawal of many of the more robust men, thus confirming the evidence obtained from the medical inquiries. The relationship of lost time to overtime is considered, and figures are quoted to show the large extent to which hours gained by overtime may be counterbalanced by lost time. In the latter portion of his study Professor Loveday discusses the loss of time before breakfast, and suggests reasons for the opinion that the employment of workers before breakfast is uneconomical and unprofitable.

Incentives to Work with special reference to Wages.—Any inquiry into the conditions of efficiency and also of the health of workers must necessarily take account of the incentives which operate to increase the output and to encourage resistance to fatigue. Of these incentives, wages are at once the most important and their effect the most difficult to determine. Any complete discussion of their effect would involve the consideration of economic problems which fall outside the scope of the Committee. The matter is, however, of such importance that they have thought it desirable to bring together data which throw light on the effectiveness of certain wage systems, and from which useful conclusions can be drawn. It should, in the first place, be obvious that a healthy environment in the factory and the home is the primary necessity for obtaining a healthy population of wage-earners to whom a wage scheme may appeal as an incentive to work; secondly, under conditions of repetition work, especially if monotonous, piece rates may be expected to give a greater output than time wages. It is however essential that the wage system should be equitable and easily understood by the worker; the evidence collected leaves no doubt that a wage system, the operation of which cannot easily be understood by the wage-earners, or, if understood, appears to them inequitable, fails to serve as an incentive. A system which is badly adjusted may lead directly to limitation of output; and the Committee are satisfied that a system which renders it possible for the wage-earners to obtain too easily the money they require for the maintenance of their normal standard of comfort fails to provide an adequate incentive. Lastly, hours of labour which give little chance of spending the wages earned diminish the incentive to earn more money. The evidence fully endorses the views already expressed by the Committee as to the necessity for a constant study of the wage sheets. The records of the wages earned under a well-planned system of piece rates should afford some index of the health and efficiency of the workers. An appendix is added in which a description is given of some of the commoner wage systems.

An inclination to rest is as natural a phenomenon as the inclination to work, and consideration is given in the memorandum to the provision of rest pauses. Reference is also made to the necessity for the instruction of the worker in the avoidance of useless movements and in methods of performing their work with less effort.

Part II.—Medical Studies.

6. The first study in this part of the Report deals with the results of the medical examination of 1,543 men over military age and 1,509 boys, while the second deals with the results of the medical examination of 1,326 women and girls, a total of nearly 4,400. It should be noted that the examinations were made between December, 1915, and August, 1916. The workers were employed in factories in all parts of the country, and every effort was made to obtain a typical and representative selection. Except for the fact that all the men and boys were examined by a single medical officer while several medical officers were employed for the examination of the women and girls, the two inquiries were conducted so far as possible on similar lines. The workers examined were divided into rough groups accordingly as their health was good, slightly below normal, or much below normal; a few of the men and boys were placed in a fourth category as being definitely in bad health, but in the case of the women this group was not separately classified. Though evidence was found of strain and fatigue, the reports agree in showing that the great majority of the workers were in good health at the time of their examination, and the medical examiners undoubtedly found less ill-health than they anticipated. It is not easy to determine the principal causes of this absence of serious ill-health or to forecast the extent to which they are likely to continue to be effective, and the investigators evidently have some doubt as to how far they are likely to be so. Patriotism and the better food and clothing obtainable as the result of the higher wages now generally earned have been undoubtedly material factors which may continue to operate. On the other hand, a continuous process of selection of the strongest workers has hitherto been in operation, but must be gradually restricted as the demands on labour increase; thus an endeavour to re-examine after six months the women previously examined at one factory showed that nearly half had left the employment of the firm. It cannot be assumed that because no serious breakdown in health has yet occurred the risk of future breakdown is negligible. Space is devoted to describing the factory and social environment of the worker, and much information is given as to the conditions under which workers lived and laboured during the period covered by the investigations, including such matters as the nature of the food eaten, housing and transit, the amount of sleep obtained by workers when on day shift and night shift respectively, and the employment of married women.

7. In selecting the data set out in these studies the Committee and their investigators have been keenly alive to the importance of taking full account of conditions of employment and other special circumstances which might affect their value, but after making full allowance for these imperfections, they are confident that the information here presented makes a substantial contribution to the correct solution of questions of immediate practical importance to employers and employed alike. The collection of such data is slow and laborious, but the results more than justify the labour involved. The value of the data, moreover, is not limited to the extent to which they throw light upon problems of immediate urgency; they are also of importance as indicating the lines on which future investigations should proceed. Progress towards greater industrial efficiency in regard to scientific application appears at present to be hampered in four directions:—(*a*) lack of observation of facts available for record and study, (*b*) lack of scientific appreciation in the directorate, (*c*) insufficient endeavour to make available existing knowledge, and (*d*) lack of inter-communication between different firms. The problems of industrial efficiency are of great complexity and variety, and can only be solved by a radical improvement in these four directions. The Committee accordingly desire to emphasise the need for the establishment of some permanent organisation for the collection of scientific data upon which alone can be based the right solution of many industrial problems intimately connected with the future prosperity and progress of the nation.

Signed on behalf of the Committee,

GEORGE NEWMAN, M.D.,
Chairman.

E. H. Pelham,
Secretary,
February, 1917.

PART I.

INDUSTRIAL AND STATISTICAL STUDIES.

INDUSTRIAL FATIGUE AND ITS CAUSES.*

CONTENTS.

Definition and Causation of Fatigue.

1. Fatigue is the sum of the results of activity which show themselves in a diminished capacity for doing work.

In ordinary language fatigue is generally associated with familiar bodily sensations, and these sensations are often taken to be its measure. It is of vital importance for the proper study of industrial fatigue, however, to recognise not only that bodily sensations are a fallacious guide to the true state of fatigue which may be present, and a wholly inadequate measure of it, but also that fatigue in its true meaning advances progressively, and must be measurable at any stage by a diminished capacity for work, before its signs appear plainly, or at all, in sensation.

2. In the animal body the performance of work depends on the activities of parts which are best considered under three groups—first, the complex nervous mechanisms of the brain and spinal cord, which are concerned in the initiation and distribution of impulses to action; second, the nerves, which conduct the impulses to muscles; and third, the muscles themselves, which by contracting finally perform external work.

Fatigue has been separately studied in all these parts. In its essential features the fatigue of all alike has been found, when it occurs, to depend not upon the simple using up—"exhaustion"—of the substances supplying the chemical energy which is liberated during work, but upon the accumulation within the living elements of the products of the chemical changes involved. Fatigue of the animal machine, that is to say, is not to be compared with the failure of fuel as in a steam-engine, or with the running-down of a clock-weight, but rather with the clogging of the wheels in some mechanism by dirt.

The chemical products of activity in the nervous and muscular elements are removed by the blood, in part directly by irrigation and in part indirectly through chemical changes in the tissue itself induced by constituents of the blood. Rest after activity is not a passive state, therefore, but is itself an active process, or a series of active processes, leading to a restoration of the normal capacity for work. Time is required for these, and the time taken will be in proportion to the amount of restoration needed. There will be a definite relation accordingly between the degree of any given activity and the time necessary for the completion of the subsequent restoration process. If the activity is repeated too quickly to give time enough for restoration after each action, fatigue will become progressively more intense as the debit balance accumulates, and each repeated act in consequence will be more and more impeded, and will become smaller, until further action is impossible.

Of the three groups of organs just mentioned, the nervous system, the nerves, and the muscles, particular chemical and structural characters will decide in each case what time-relation must exist between action and the rest needed for

* Previously issued by the Health of Munition Workers Committee as Memorandum No. 7.

complete repair. In the conducting nerve fibres fatigue may be said not to occur; it is unrecognisable probably because of the extreme rapidity with which recovery here follows the very small changes associated with activity. Of the other two groups, the initiating and distributing nervous mechanisms of the brain and spinal cord are more quickly fatigued than the contracting muscles, and the important result follows that in the animal body the impulses to activity springing from the brain cannot bring the muscles far towards complete fatigue before their sources are themselves fatigued and impotent. Even beyond that point, when the central nerve cells are inactive, impulses artificially sent, in experiment, along the indefatigable nerve fibres will still fail to produce more than partial fatigue in the muscles, for fatigue advances faster still in certain structures known as the end-organs, which connect nerve fibre and muscle; there the impulses become blocked so that the muscle again escapes from further activity.

In the tired man the symptoms of fatigue are referred to the muscles; they ache, or they may appear to " give way under him." but in reality the most severe bodily activity fails to produce any close approach to complete fatigue of the muscles. The fatigue is fatigue of the nervous system, though in sensation its effects may be referred to the muscles themselves. A hunted animal may be driven to intense muscular fatigue, but in this extreme case the blood becomes charged with chemical products of activity, for the elimination of which no opportunity is given, and the muscles, with every other organ of the body, become poisoned. Even in laborious work it is doubtful whether a man by voluntary effort can cause his muscles to approach advanced fatigue. It is well known that a man apparently " run to a standstill " in a race may upon some new excitement run freshly again, under augmented stimulus from the nervous system, initiated there perhaps in part along new paths.

The problems then of industrial fatigue are primarily and almost wholly problems of fatigue in the nervous system and of its direct and indirect effects.

The Rhythm of Action and Rest.

3. The necessary time-relation between an action and the recovery from it in rest has been mentioned already. For every acting element a given rhythm of activity will allow exact recovery after each act, and will maintain the balance between action and repair throughout a long series. The heart, for instance, in alternating contraction and relaxation, may continue to beat incessantly through the life of a man without any accumulated fatigue for seventy years or more. Among the great variety of nerve centres there will be found a great variety in these time-relations. Some may allow a relatively rapid rhythm, as in the act of breathing, where the rhythm, which is a nervous rhythm, may be almost incessant for years, while at the other end of the scale there are slower rhythms like those shown in the need for diurnal sleep.

In connection with this natural pace of the animal machine, to and fro, from action to rest, reference must be made to the wide adaptability of the animal mechanisms, and especially to that of the nervous system, in response to training and use. Complicated co-ordinations in the nervous system, at first easily fatigued, may by training, and, as it seems, by some improvement in the routes of connection due to the increase of traffic itself, become capable of maximum efficiency at a more rapid rhythm. A man will swing each leg, weighted with a heavy boot, as in walking, for 10,000 times in an unbroken march without notable fatigue, but he cannot as an impromptu exercise raise his lightly weighted finger for more than a few score times at no faster rate before the movement comes to complete standstill.

4. The problem of scientific industrial management, dealing as it must with the human machine, is fundamentally a problem in industrial fatigue. The rhythms of industrial conditions, given by the hours of labour, the pace of machinery or that of fellow-workers, or otherwise, are imposed upon the acting bodily mechanisms from outside. If these are faster than the natural rhythms, they must give accumulated fatigue, and cause an increasing debit, shown in a diminished capacity for work. It is therefore the problem of scientific management to discover in the interests of output and of the maintained health of the workers what are the " maximal efficiency rhythms " for the various faculties of the human machine.

These must be determined by the organised collection of experience or by direct experiment. They must be separately determined, moreover, not only for the performance of relatively simple muscular movements, all of which depend on the action of "lower" nervous centres, but also for the "higher" co-ordinating centres, and for both of these the natural rhythms must be studied for the best arrangement of short spells, and again for that of the hours of shifts, of the periods of sleep, and, at the last point of the scale, of holidays.

Signs and Symptoms of Fatigue.

5. It must be repeated that the subjective sensations of fatigue are not a measure, or even an early sign, of it. Real or objective fatigue is shown and is measurable by the diminished capacity for performing the act that caused it.

6. *Bodily Fatigue.*—Fatigue following muscular employment is primarily nervous fatigue, as explained already, and we have seen that no advanced degree of muscular fatigue as such can be obtained by voluntary action, for fatigue in the nervous system outstrips in its onset fatigue in the muscles. In accustomed actions, however, as in walking or digging, where there has been habituation, the activity may be so prolonged without great nervous fatigue as to give approaching "exhaustion"—that is, notable loss of chemical substance—in the muscles. Industrial work is habitual work, but the case in which muscular labour is so intense and prolonged as to give exhaustion in this sense need not be considered here, nor the causation of the special symptoms which arise. It must be noted, however, that practically the whole of the mechanical energy and heat yielded by the body during work comes from the chemical energy stored in the muscles. In proportion as this store is called upon, and quite apart from the question of fatigue, it must be made good by supplies from the blood and ultimately from the food. Practically the whole of the energy transformed in the muscles is derived from carbohydrate material, and the importance of this in relation to the diet of workers is discussed in Memorandum No. 3.

For work in which severe muscular effort is required it seems probable that the maximum output over the day's work and the best conditions for the workers' comfort and maintained health, will be secured by giving short spells of strenuous activity broken by longer spells of rest, the time-ratio of rest to action being here, for maximal efficiency, greater than that for the employments in which nervous activity is more prominent or more complicated than in the processes involved during familiar muscular work.* This difference may be connected directly with the greater bulk of chemical material which must be mobilised when, as in severe muscular exercise, so large a proportion of the whole body mass is engaged in the chemical events involved in movement and doing work; but further scientific study is needed here.

7. *Nervous and Mental Fatigue.*—It is under this head, as we have seen, that the special problems of industrial fatigue arise. The signs and symptoms of the fatigue will depend upon the nature of the particular work done, whether it be general bodily work of this or that kind, carried out in fixed routine, or whether it involve mental activity of a simple or of a more complicated kind. The fatigue may spring from the maintained use of intelligence and observation with varying degrees of the muscular effort necessary in every kind of work, or from the maintenance of steady attention upon one skilled task, or of distributed attention, as when several machines are to be tended or other manipulations performed. Or again, it may depend upon the continued use of special senses and sense-organs in discrimination, whether by touch or sight. It will be affected greatly according to whether the worker has opportunity for obeying his natural rhythms, or whether

* This point is one of incessant practical interest in many industries, and it may be noted that it has an immediate bearing upon the routine proper for rapid trench-digging. Two officers at the front recently, for a friendly wager, competed in making equal lengths of a certain trench, each with an equal squad of men. One let his men work as they pleased, but as hard as possible. The other divided his men into three sets, to work in rotation, each set digging their hardest for five minutes and then resting for ten, till their spell of labour came again. The latter team won easily. The problem here gives another obvious opening for scientific organisation based on the results of experiment.

unnatural rhythm is imposed upon him by the pace of the machine with which he works or by that of his fellow-workmen. Considerations so inexplicable at present in terms of physiology as to be called " psychological " will also arise; if the work is of a " worrying " or " fussy " kind, with a multiplicity, that is to say, of imposed and irregular rhythms, fatigue will be more rapid, perhaps on account of the more numerous, and " higher," nervous centres which become implicated.

Monotonous work—and much industrial work is monotonous—offers some special problems. It has been seen that uniformly repeated acts tend to become in a sense " automatic," and that the nerve centres concerned become less liable to fatigue—the time ratio of necessary rest to action is diminished. But when monotonous series are repeated fatigue may appear in what may be called the psychical field, and a sense of " monotony " may diminish the capacity for work. This is analogous to, if it does not represent, a fatigue process in unrecognised nervous centres. Conversely, " interest " may improve the working capacity even for a uniform monotonous activity, and the interest may spring from emotional states, or, as some think, from states of anticipatory pleasure before meal-time and rest (" end-spurt "), or again, from a sense of patriotism eager to forward the munitions output.

It may be remarked that mental processes, like those involved, for instance, in adding up figures, may be maintained for very long periods—subject to the needs of change of posture and of diurnal sleep—with no great loss of capacity, that is without marked fatigue in that particular process. Such diminution of capacity as occurs, and the sense of fatigue that is felt subjectively by common experience in such a task, appear to be due to " monotony," and to be removable by means of " interest."

8. For practical purposes in industrial management two chief characters of nervous fatigue must be observed. First, during the continued performance of work the objective results of nervous fatigue precede in their onset the subjective symptoms of fatigue. Without obvious sign and without his knowing it himself, a man's capacity for work may diminish owing to his unrecognised fatigue. His time beyond a certain point then begins to be uneconomically spent, and it is for scientific management to determine this point, and to determine further the arrangement of periods of rest in relation to spells of work that will give the best development over the day and the year of the worker's capacity. Second, the results of fatigue which advances beyond physiological limits (" over-strain ") not only reduce capacity at the moment, but do damage of a more permanent kind which will affect capacity for periods far beyond the next normal period of rest. It will plainly be uneconomical to allow this damage to be done.

For these reasons, chief among others, it will be important to detect latent fatigue, and since sensations of fatigue are unpunctual and untrustworthy, means must be sought of observing the onset of fatigue objectively.

Tests of Industrial Fatigue.

(*a*) *Output.*

9. The true sign of fatigue is diminished capacity, and it follows from what has been said that measurement of output in work will give the most direct test of fatigue.

The output must be measured under the ordinary conditions of the work, and, in cases where from the nature of the work the output is not automatically measured, it must be tested by methods which do not allow the workers to be conscious at particular times of the test being made. In this way the errors due to special effort from interest or emulation will be eliminated. The results of work expressed in output must be corrected by allowance for all variable factors save that of the workers' changing capacity; changes in supply of steam or electric power and of raw material, for instance, must be determined for the correction and interpretation of the actual output returns. The output must be estimated for successive short periods (*e.g.*, each hour) of the day's work, so that the phenomena of " beginning-spurt " and " end-spurt," and other variations complicating the course of fatigue as such, may be traced and taken into account. Isolated tests of output

taken sporadically will be meaningless. The records must also extend over longer periods to show the onset of fatigue over the whole day and over the whole week, and under particular seasonal or other conditions, in order to detect and measure the results of accumulating fatigue.

10. Measurements of output must obviously be recorded at so much for each individual or for each unit group. The size of total output will be meaningless of course without reference to the numbers engaged. But it will also be important for proper management to take account of the output of particular individuals. This in many factory processes is easily possible, and when it has been done the results have shown surprising variations of individual output which are independent of personal willingness and industry, and have generally been quite unsuspected by the workers and their supervisors before the test was made. Information so gained is valuable in two respects. Good individual output is often the result of escape from fatigue by conscious or unconscious adoption of particular habits of manipulation or of rhythm. Its discovery allows the propagation of good method among the other workers. In the second place, these tests of individual capacity (or its loss by fatigue) give an opportunity for a rearrangement of workers and their assignment to particular processes of work. Astonishing results, bringing advantage both to employers and employed, have been gained in other countries by the careful selection of individuals for particular tasks, based not upon the impressions of foremen but upon the results of experiment.*

11. If the proper adaptation to particular kinds of labour of the relations of spells or shifts of work to rest intervals and to holidays is to be determined, as it can alone be, by appeal to experiment, it will of course be an essential condition for success that the workers should co-operate with the employing management and give their highest voluntary efforts towards the maximum output during the spells of work. It is not surprising that where employers, following tradition rather than experiment, have disobeyed physiological law in the supposed interests of gain—and for a century this has been almost universal—the workers have themselves fallen very commonly into a tradition of working below their best during their spells of labour. In so far as hours of work in excess of those suitable for maximal efficiency have been imposed during the last two or three generations of modern industry upon the workers a tradition of slowed labour must necessarily have arisen, probably in large part automatically, as a kind of physiological self-protection. Without some conscious or unconscious slackening of effort indeed during working hours of improper length in the past, the output might have been even more unfavourable than we know it to have been for the hours of work consumed.

It has happened, moreover, that, rightly or wrongly, a suspicion has grown up among workers that any device for increasing output will be used for the profit of the employer rather than for the increased health and comfort of the workers. It would be out of place here to touch on the economic and social problems which arise in this connection, but until such solutions are found for them as will bring a hearty co-operation between employers and employed, in the task of finding the optimum conditions of work for the benefit of both, there will be no certain prospect of determining the true physiological methods for getting the best results in modern industrial occupations.

The Committee believe that in the present time of crisis patriotic incentive has done much to abolish customary reduction of effort among munition workers, but it is of great importance to note that a special and strenuous voluntary effort in labour, if it be maintained under a badly arranged time-table of work and rest, does not necessarily bring increased output over a long period, however praiseworthy the intention of effort may be. Under wrong conditions of work, with excessive overtime, it is to be expected indeed that some deliberate " slacking " of the workers might actually give an improvement of output over a period of some length by

* In certain special directions, and with special regard to munition work, the Committee are causing some experimental observations to be made for their guidance. The services of Mr. Sargant Florence, working on behalf of the Medical Research Committee (National Health Insurance), have been placed at the disposal of this Committee, and he is engaged in studying particular features of output under special conditions of labour at particular factories. In this work he has enjoyed the cordial co-operation of the manufacturing firms concerned, and to these the Committee would offer their grateful acknowledgments. The Committee propose later to make appropriate use of the results of these investigations.

sparing wasteful fatigue, just as the " nursing " of a boat-crew over part of a long course may improve their performance. It cannot in such circumstances be said that a workman so restraining himself, consciously or unconsciously, is doing more to damage the output on the whole than the employer who has arranged over-long hours of work on the baseless assumption that long hours mean high output.*

> In a specific instance before the Committee, a group of five male voluntary Sunday workers in a certain munitions factory were able in 8 hours (or 7 hours free of meals) to exceed the average day's output of eight week-day men, who work 14 hours (or 12½ hours free of meals). These five men worked, no doubt, at a " sprint," which could not perhaps have been maintained daily. But there can be little doubt that they could repeat their 8 hours' effort on, say, four days in a week; and, if so, the startling result follows that they could do in those four days rather more than the whole week's work of an equal set of men adopting the other system of hours. With this, moreover, they could enjoy not only longer nights and more recreation time in each working day, but could also have three whole holidays in the week. Would these five volunteers be " slackers " if they did a full week's work judged by the 14-hour standard, or more, but had three holidays a week (available perhaps for a change of work) and slept longer at night? It is impossible to resist the conclusion that the paid week-day workers at this factory, who have been working their long hours for many months, might have greatly improved both their output and their comfort under a better chosen system of special efforts alternating with suitable rests. The work in question was work of a uniform " repetitive " kind, involving moderate physical exertion.
>
> At another large factory the manager is considering closely the problems raised here. He is proposing to aim at " sprint," and hopes to get the same output from 7½ hours' work as from the present 10½ hours' work. He instituted a competition as to which shift and which group of men could do most as an experiment. He found that a small bonus " increased the output of a group of boys 120 per cent."
>
> At one long-established factory a new shop has been built and staffed so as to produce 5,000 of a particular stock article of warfare per week, that estimate being based upon the results of the older shops doing the same work. New hands were engaged, and these in the new shop are now, after six months, producing in spite of their inexperience not only 5,000, as expected, but 13,000 of these articles per week. The older hands in the other shops do not approach this output, though all the mechanical conditions of work are practically equal. As patriotic interest in their output appears to be shared here by all the men alike, the lower output by the more experienced hands appears to be assignable only to the effects of long-standing customary restrictions upon habits or rhythm of work from which the newer hands are free.

In addition to the direct measurement of output certain secondary symptoms of fatigue may be studied usefully as its index.

(*b*) *Accidents and Spoiled Work.*

12. An important and early sign of fatigue in the nervous centres is a want of co-ordination and failure in the power of concentration. This may not be subjectively realised, but may be shown objectively in an increased frequency of trifling accidents. The accidents are due to momentary loss of attention, and may result in personal damage to the worker, trifling or serious, breakages of tools or materials, or the spoiling of work. In well-managed factories the incidence of accidents of this kind is recorded for unit periods throughout the day. and these records may provide a good secondary index to fatigue, but only in so far as they are corrected by reference to the rate of work being done and other variables. Results of the use of this method by Mr. Sargant Florence have recently been published in the report made to the British Association at Manchester in last September. but at present these results lack the necessary parallel determinations of rate of output and other factors for their correction.

(*c*) *Associated Fatigue and Laboratory Tests.*

The primary sign of fatigue in a given function is diminished capacity. But there is evidence to show that accumulated fatigue in connection with a given act

---

* It is said that women workers now engaged upon munitions have no customary usages of sparing themselves, and that the weekly output per woman often exceeds that per man. The experienced manager of a large shell factory employing 1,200 men and 1,500 women expressed his confidence that the three 8-hour shift system gives better output and maintains better health than that of two 12-hour shifts. He is " satisfied that there is a period of slacking, *often quite unconscious*, during a 12-hour shift which is detrimental to output." Investigation elsewhere suggests, however, that the output for the long shift might be even worse without this unconscious restraint.

may affect adversely the condition of other parts of the nervous system not immediately employed. There is little experimental knowledge, however, as to whether this effect, shown in associated fatigue, is more direct and definite in kind than the effect upon general health to be mentioned below. The appearance of associated fatigue will need for its detection and study the application of special tests, involving the use of suitable apparatus and laboratory accommodation. The Committee are causing some observations of this kind to be made, and the results of these will be the subject of a later report if it appears desirable.

It should be remembered, however, that experiments of this kind will have no validity unless the fallacies due to emotions and ideas, such as a sense of novelty, interest in the desired result, anticipation of release from experiment, unconscious suggestion by the observer, and so on, are eliminated by the most rigid attention to experimental conditions and by long series of control observations. The objects of experimentation must be trained for the purpose. and it is unlikely that tests of this kind will offer results of sufficient value to justify the special education of teams of selected workers for the prolonged studies which the method demands.

Professor Stanley Kent has communicated recently to the Home Office* the results of some preliminary experiments in this connection. He has inquired whether fatigue due to industrial work shows its effects in associated changes of nervous functions not directly employed in it, as for instance in diminishing the quickness of response to signals, in blunting the acuity of hearing, or the acuity of vision, or in lowering other nervous functions. His general findings are sufficient to show that these indirect associated results of fatigue provide no regular and trustworthy index of the primary fatigue. They give indications, but irregularly in some cases and not at all in others, that the general " tone " of the nervous system is depreciated after a day's work, and declines also during a week's work.

(*d*) *Sickness, Lost Time, and " Staleness."*

13. The accumulated results of fatigue are damaging to general health, and they will be reflected in the sickness returns and in the returns of lost time. Many problems arise here which cannot be discussed in detail,† and they are complicated by the influence of other factors which will be discussed in the following section. Without complete analysis of other variables, sickness returns will be only an indirect guide in the study of fatigue as such.

14. Reference must be made here, however, to a pronounced and common symptom of industrial fatigue, which appears to be the reflection in the workman's general health and " spirits " of the results of accumulated nervous fatigue rather than a direct or measurable sign of it. At the present time in very many munition factories the complaint is made by workers, and not least by the most intelligent and willing of them, that they are feeling " done up," or " fair whacked," to use local phrases, and the evidence shows that this state of " staleness " is becoming increasingly common and obvious. By experienced managers and medical officers this condition of staleness is attributed almost wholly to persistent long hours and the deprivation of weekly rest. It has grave accompaniments, which paradoxically appear not only in a state of lethargy and indifference, but also in a craving for change and excitement. No doubt the restlessness of the condition must often predispose also to indulgence in the alleviations given by alcohol. At all points the state is apt to set up a vicious circle in which the very need for change and rest prevents the proper use of such chances of rest as are given.

The following is typical of many reports made to the Committee :—

" The works manager who showed me round had worked 361 days out of 365, and looked worn. He would welcome Sunday holidays. A skilled tool-maker had had eight days' holidays—including one for a funeral—since the War began (14 months). He complained of the strain on his nerves."

The officials of a very large Trade Union said that overtime " was generally considered to be excessive. The most skilled workmen were becoming nervy."

Proper attention earlier in the War to the need for weekly rest would have prevented a large part of the diminished capacity of this kind that has been allowed to appear, and would have averted much costly and wasteful expenditure upon im-

* Interim Report on an investigation of Industrial Fatigue by physiological methods [Cd. 8056]. Price 4½d.

† Further reference is made to this subject in the Committee's Memorandum on Sickness and Injury.

perfect work. But stress must be laid here on a further point. For the avoidance of staleness in conditions of strenuous labour it is not enough to treat workmen in the bulk and to regulate daily and weekly rests upon a physiological basis devised for the average. If that be done, widespread evils like those too commonly present now may be avoided, but good management will consider always the individual workman as well. The Committee have no doubt that in very many cases, perhaps in almost all, in which staleness is well marked or has even advanced to definite sickness, a single " day off," given occasionally at the right time, would have avoided much wasteful reduction of capacity and in the worst cases the total loss of many days of work.

The Study of Industrial Fatigue.

15. By studies of industrial fatigue measured by tests of individual output a large body of valuable information has already been gained in various countries, and its application wherever management is scientific has become a commonplace of administration.* It must be admitted, however, that in England, and no doubt to the detriment of both health and wealth, management based upon the experimental science of industrial fatigue is far less common than in the factories and business concerns of America and of Germany. The Committee, in their Memorandum (No. 5) upon Hours of Work, par. 7, have already pointed to the surprising uncertainty commonly found in this country, even where professional knowledge is to be expected, with regard to the proper solution of some of the most elementary practical problems of labour management.

16. In the rapid enlargement and organisation of munition factories in this country there has been, and is, the most urgent need for the application of the results of experience scientifically acquired. Upon a sudden national emergency the accumulation of fatigue and its results in workers might well be temporarily disregarded, but now, though the special need persists, the race is to be a long one, and a failure to conserve the maximum efficiency of the workers must be disadvantageous. Misguided efforts to stimulate workers to feverish activity in the supposed interests of the country are likely to be as damaging to the desired result as the cheers of partisans would be if they encouraged a long-distance runner to a futile sprint early in his race.

Even during the urgent claims of a war the problem must always be to obtain the maximum output from the individual worker which is compatible with the maintenance of his health. In war time the workmen will be willing, as they are showing in so many directions, to forego comfort and to work nearer the margin of accumulating fatigue than in time of peace, but the country cannot afford the extravagance of paying for work done during incapacity from fatigue just because so many hours are spent upon it,† or the further extravagance of urging armies of workmen towards relative incapacity by neglect of physiological law.

The Committee have found many isolated instances in which the onset of industrial fatigue has been avoided by intelligent observation of the output and of the returns of sickness and of lost time, and by prompt initiative in adapting the hours of work to physiological need; but these instances are exceptional. Taking the country as a whole, the Committee are bound to record their impression that the munition workers in general have been allowed to reach a state of reduced efficiency and lowered health which might have been avoided without reduction of output by attention to the details of daily and weekly rests. The signs of fatigue are even more noticeable in the case of the managers and foremen, and their practical results are probably more serious than in the case of the workmen.

Examples may be given of the value of intelligent management :—

At a large shell-making factory the men for the early months of war worked seven 12-hour day and seven 12-hour night shifts in the week. More recently Sunday work has

* References to published work may be found conveniently in " Fatigue and Efficiency," by Josephine Goldmark, New York, 1913 (3rd edit.) and in the Interim Report to the British Association (Manchester, 1915) by the Committee upon the Question of Fatigue from the Economic Standpoint.

† On the question of Sunday work by exhausted men, one foreman said he did not believe in " a holiday on double pay." Another remarked that Sunday work gave " six days' output for seven days' work on eight days' pay."

been stopped (or at least every man has a weekly day of rest), and the men work from 6 a.m. to 7.30 p.m., with half an hour for breakfast and an hour for dinner, tea being brought to the men by the boys while the machinery is running. These hours are long but as a result of improvements in organisation, they now produce an increased number of shells from half the number of workers. The manager here " attaches the greatest importance to the week-end rests."

At another large munitions factory men engaged in the heavy work of moulding are required by the management to rest 15 minutes in every hour of work. The manager was satisfied that this was an arrangement good for the men and for the output. But the men objected to this long spell of rest in each hour because the work was piece-work, and they thought the production would be lessened by it. The manager accordingly found it necessary to set a foreman to watch and to make the hourly rest compulsory. When this was done the output per hour was found to be actually increased.

At another munitions factory the Committee learnt that the manager had given a break of 15 minutes daily at 11 a.m. to girls engaged in sedentary work of a monotonous repetitive kind. During the break the girls had recreation in the open air. In spite of this deduction from their working hours of the time so spent, the output per day was increased.

17. The problems of industrial fatigue, already soluble in part by reference to an available body of knowledge well known and used in other countries, have become acute during the great recent development of the munitions industries of Great Britain. It is not too much perhaps to hope that the study of industrial fatigue and the science of management based upon it, which is now being forced into notice by immediate need, may leave lasting results to benefit the industries of the country during succeeding years of peace.

Our national experience in modern industry is longer than that of any other people. It has shown clearly enough that false ideas of economic gain, blind to physiological law, must lead, as they led through the 19th century, to vast national loss and suffering. It is certain that unless our industrial life is to be guided in the future by the application of physiological science to the details of its management, it cannot hope to maintain its position hereafter among some of its foreign rivals, who already in that respect have gained a present advantage.

OUTPUT IN RELATION TO HOURS OF WORK.*

BY

H. M. VERNON, M.D., Fellow of Magdalen College, Oxford, and University Lecturer in Chemical Pathology.

CONTENTS.

Introduction.

1. In a previous Memorandum (No. 5) the Committee recommended that the average weekly hours of labour, including overtime, should not exceed 65 to 67 for men, and 60 hours for women. They suggested that it might be desirable to differentiate to some extent between different kinds of work, but they did not offer any detailed information, because at the time they had not sufficient data at their disposal to warrant definite conclusions. In order to remedy this deficiency, special investigators, including myself, have been engaged for many months past in collecting statistics concerning output in relation to hours of labour at a number of munition works, and I am now bringing forward a portion of the data which I have obtained as they appear to me, not only to afford information concerning the most suitable hours of labour in certain specific munition operations, but also to suggest some of the principles which should be followed in fixing the hours of labour for munition work in general.

2. I understand that the object of the Committee is in many ways similar to that of the Managers of Munition Works, and is to ascertain the hours of employment most likely to produce a maximum output over periods of months, or maybe even of years. They hold that output cannot be maintained at the highest level for any considerable period if the conditions are such as to lead to excessive fatigue and to deterioration in the health of the workers. If health and physical efficiency are maintained they would raise no *a priori* objections to any given number of hours, however long. Further, in considering the relative value of, say, a 65-hour week as compared with a 55-hour week the question is, whether the former or the latter will produce the greater total weekly output, rather than whether any extra cost involved by the additional output is justified by the economic or military conditions existing at any given time.

3. The statistical data collected with one exception concern the output of day shifts, and they were collected in large and recently built munition works where the conditions of labour such as lighting, warming, ventilation and the provision of canteens, were as favourable as possible. All classes of operatives were on piece work, they were paid at a high rate of wages, and there were no Trades Union restrictions whatever upon output. Hence there was every possible stimulus for them to exert their maximum powers of production. It is more convenient to describe first the data obtained relating to the output of women, as one group of them is specially complete.

Women Engaged in Moderately Heavy Labour.

4. The complete series of output data just referred to concern women engaged in turning aluminium fuze bodies. The operatives were standing all day at capstan lathes, and had to subject each fuze body to seven successive boring and cutting operations. These operations required close attention throughout and some delicacy of manipulation, so that no relaxation of effort was permissible during the actual turning. Nearly 200 operatives were engaged on the work, but for the purposes of statistical analysis the output of only 100 of them could be considered. None were included unless they had attained their maximum output (which statistical examination of individual output showed was attained after three weeks' experience), and were engaged on the operation for 15 or more weeks out of the 24 weeks of the statistical period dealt with. For many months previous to this period the hours of labour had usually been 77¼ per week, except that

* Previously issued by the Health of Munition Workers Committee as Memorandum No. 12.

in the second week of each month there was no Sunday labour, or the hours were reduced to 69¼ per week. From Table I we see that in the six-week period just before Christmas

Table I.—100 women turning fuze bodies.

Week ending	Actual hours of work per week.		Nominal hours of work per week.	Hours of broken time per week.		Relative output per working hour.		Hours of work × Relative output.	Remarks concerning output.
Nov. 14	62·0		67·5	5·5		98			
„ 21	68·8		75·5	6·7		99			
„ 28	66·7	68·2	75·0	8·3	6·6	102	100	6,820	Hourly output fairly steady.
Dec. 5	70·9		77·2	6·3		96			
„ 12	69·1		76·2	7·1		99			
„ 19	71·8		77·3	5·5		107			
„ 26	41·8		46·0	4·2		105			Typical rise in hourly output before holiday.
Jan. 2	32·8		—	—		89		—	Great fall in hourly output immediately after holiday.
„ 9	65·2		69·3	4·1		113			
„ 16	70·3	68·6	77·2	6·9	5·7	107	111	7,615	Subsequent considerable increase of hourly output, whilst total output rises to a maximum, 12% greater than that of pre-Christmas period.
„ 23	70·3		76·3	6·0		112			
„ 30	62·4	61·6	68·5	6·1	5·9	111	107	6,591	Reduction of hours of labour from 74·3 to 67·5 has no immediate effect on hourly output, hence a considerable reduction of total output.
Feb. 6	60·8		66·5	5·7		102			
„ 13	49·2	48·4	52·0	2·8	3·6	108			Temporary shortage of material and reduction in hours of labour.
„ 20	47·6		52·0	4·4		106			
„ 27	61·4		66·5	5·1		118			
Mar. 5	62·2		66·5	4·3		125			
„ 12	54·8		58·5	3·7		127			Effect of shorter hours of labour now established, and hourly output reaches a maximum. Total output 8% greater than in pre-Christmas period.
„ 19	62·1	59·7	66·5	4·4	4·6	121	123	7,343	
„ 26	60·4		66·5	6·1		121			
Apr. 2	58·6		64·8	6·2		121			
„ 9	54·9		58·5	3·6		121			
„ 16	62·9		66·5	3·6		126			Typical rise in hourly output before holiday (Easter).
„ 23	47·0		49·5	2·5		125			

the actual hours of work averaged 68·2 per week, or 6·6 hours less than the nominal hours (74·8 hours). Taking the average hourly output of fuze bodies as 100, the total (relative) output per week comes to 6,820. The next fortnight was much broken by the Christmas holiday. This amounted practically to a week if the days taken without permission be added to those officially sanctioned. It will be noted that in the week and a half before this holiday the output rose distinctly above the previous average (viz., 6 per cent.), but in the half week immediately following it fell considerably below the average (viz., 11 per cent.). Both of these variations form a typical feature of output data in relation to holidays, whilst another typical feature is the considerable and persistent rise which follows on a holiday. In the present instance this rise amounted to 11 per cent. more than the average for the pre-Christmas period, or the total output reached its absolute maximum of 7,615 per week. The beneficial effects of the holiday upon output undoubtedly lasted four weeks, and probably more, but the reduction in the hours of labour from January 24 onwards precluded the possibility of tracing it further. After a four days' holiday at the beginning of August, the output of a smaller group of the operatives, 40 in number, remained high for five weeks, and was 7 per cent. greater than the average output during the next eight weeks.

5. The output data of Table I indicate that the beneficial effect on output of a reduction in the weekly hours of labour from 74·3 to 67·5 was not immediately manifest. Even a reduction to 52·0 hours seemed to have no influence, but this was owing to a temporary shortage of material. From February 27 onwards the hours of labour were 66½ per week (or 58½ in the second week of each month, when there was no Sunday labour), and we see that during a perod of eight weeks the hourly output now averaged 23 per cent. more than in the pre-Christmas period. The total output is 7,343 per week, or 8 per cent. more than in the pre-Christmas period, in spite of the hours of labour being nominally 10·5 less, and actually 8·5 less. It is probable that the 60 hours worked per week were still too many to give the best total output, but at least they justify the statement that *in order to attain a maximum output women engaged in moderately heavy manual labour should not work for more than* 60 *hours per week.* Observations adduced below suggest that an equally good total output could be maintained if the actual working hours were reduced to 56 or less per week.

6. It might be thought that the great improvement in hourly output under the shorter hours régime was due, partly or wholly, to increased skill of the operatives or improvements in the machinery. Neither of these hypotheses can be substantiated. On classifying the operatives into two groups, according as they had been engaged in turning fuze bodies for about five months previous to the statistical period dealt with, or for about one and a half months on an average, the hourly output of the former group was found to be 1 per cent. less than that of the latter group during the pre-Christmas period, and 1 per cent. more than it during the spring period, or in other words it was the same within the limits of chance error. As regards the other alternative, no change had been made in the tools, the machinery, the nature of the operation or the quality of the alloy used during the statistical period dealt with, or for 4½ months previous to it.

7. Further proof of the advantage of shorter hours was afforded by the output data of some of the operatives on an earlier occasion. One group of them, 17 in number, worked only 51·8 to 62·6 hours per week for five weeks in June and July, and during the last three weeks of this period their hourly output was 18 per cent. greater than that of another group of 14 operatives who were working the usual long hours. Subsequently, when both groups worked the same long hours, their output was identical.

Broken Time and Sickness.

8. It will be seen from Table I that the operatives lost on an average 6·6 hours per week of "broken" time before Christmas, and 4·6 hours per week in the final eight-week period, or that they lost practically half a day per week in this way. But even this does not represent by any means the total time lost, for I have put in a separate category such time as was presumably lost by indisposition. I have made the arbitrary assumption that operatives who put in less than 45 hours per week of actual work out of a nominal 58½ or more did so because of sickness rather than slackness, and I have excluded them in calculating the broken time data quoted in the Table, though I retained them when calculating the output of fuze bodies per working hour. In the six-week pre-Christmas period 4·1 per cent. of the weeks worked by the operatives were "short" weeks of less than 45 hours, the average time of actual work amounting to 30·2 hours per week. In addition, the operatives were absent altogether for 2·1 per cent. of the weeks. Sickness increased considerably after Christmas, for in the five-week period, January 3—February 6, 5·7 per cent. of the weeks were short weeks, and 3·6 per cent. of them were absent weeks, whilst in the seven-week period, February 21—April 9, no less than 12·4 per cent. of the weeks were short weeks (averaging 28·6 hours), and 5·4 per cent. of them were absent weeks, in spite of the fact that the nominal hours of labour were 10·8 less than in the pre-Christmas period.

9. There can be no doubt that the frequent occurrence of these short and absent weeks was due very largely to fatigue resulting from the strain of the heavy lathe work, for women engaged in light sedentary occupations showed only about a third as many lapses. I was able to obtain data concerning the timekeeping of no less than 400 women and girls engaged in the sedentary occupations of viewing, gauging and assembling the component parts of fuzes, and in Table II are given the

Table II.—Weeks in which operatives worked less than 45 hours, or were absent.

Age of operatives.	Number of operatives.	Short weeks.			Absent weeks.		
		6 weeks before Christmas.	5 weeks after Christmas.	7 weeks following (Feb. 7—Mar. 26, or Feb. 21—Apr. 9.)	6 weeks before Christmas.	5 weeks after Christmas.	7 weeks following.
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
14—16	71 fuze gaugers	1·3	1·7	3·6	2·9	1·7	1·4
17—18	58 fuze gaugers	0·3	3·1	5·0	0·7	3·8	2·4
19—20	96 fuze gaugers	2·4	2·8	6·4	2·0	1·7	3·3
21 and over	175 fuze gaugers	1·4	2·1	3·4	0·7	2·1	1·8
21 and over	100 fuze turners	4·1	5·7	12·4	2·1	3·6	5·4

average numbers of short and absent weeks observed in the six weeks before Christmas, when the nominal hours of labour were 76 per week; in the five weeks after Christmas, when they were 75 per week; and in the subsequent seven weeks (February 7—March 26), when they were 64 per week. Taking first the women of 21 and over, for they alone are strictly comparable in age with the fuze-turning women, it can be seen that in each of the statistical periods dealt with these women put in only about a third as many short weeks as the fuze-turners, whilst they were absent three times less frequently in two of the statistical periods, and about half as frequently in the third period.

10. As regards the girls engaged in sedentary work, the Table shows that those of 19—20 years put in the most short and absent weeks, whilst those of 14—16 put in the least, and in this respect corresponded closely with the women of 21 and over. In Table III are recorded the average hours

Table III.—Broken time of women gauging fuzes.

Age of operatives.	Number of operatives.	Average hours of broken time per week during		
		6 weeks before Christmas.	5 weeks after Christmas.	7 weeks following.
14—16	71	2·9	3·9	3·2
17—18	58	3·9	5·2	3·0
19—20	96	3·5	5·9	4·0
21 and over	175	2·5	4·7	3·0

of broken time observed in the three statistical periods mentioned, and it will be seen that here again the girls of 14—16 resembled the women of 21 and over in keeping the best time, whilst the young women of 19—20 were on the whole the worst timekeepers. If comparison be made with the data relating to the fuze-turning women, it will be seen that on an average the adult women engaged in this sedentary work lost only about half as much time as they did.

11. It should be mentioned that these gauging women were not on piece rates like all the others, but were on day rates with the addition of a large bonus on output if above a certain minimum. Doubtless this system of remuneration tended to improve their timekeeping to some extent, though probably not much. Thus the group of women recorded in the next section, who were engaged on the light labour of milling a screw thread, were paid at piece rates, and yet kept time very much better than the fuze-turning women, and not much worse than the gauging women.

12. It is evident that in fixing the number of hours required to produce a maximum output close attention must be paid to the effect of any given number of hours on timekeeping. If an increase in the hours of labour from 50 to 60 per week caused the total output of the operatives, taken as a group, to increase permanently by, *e.g.*, 10 per cent., it would be worth while to adopt these hours, but if after a few weeks of the longer hours it were found that 5 per cent. more of the operatives were absent from sickness, and 10 per cent. more of them were putting in short weeks of an average of 30 hours instead of the nominal 60 hours, there would be no gain whatever in the total output. Now it will be seen from Table II that in the third of the statistical periods dealt with 9 per cent. more of the fuze-turning women were putting in short weeks than of the gauging women, whilst 3·6 per cent. more of them were absent. If, therefore, it were found that by cutting down the hours of actual work of the fuze-turning women from 60 to 56 they were able to reduce their short and absent weeks to those shown by the gauging women, the output would remain practically unchanged. For other and independent reasons, to be mentioned later on, it seems probable that a reduction of the working hours to 56 per week would have no adverse effect on output, and hence there can be little doubt that this number of hours is the absolute maximum for the type of work under consideration, and that if anything it errs on the side of excess.

13. Another point to be borne in mind in fixing hours of labour is the time taken by the operatives to get from their homes to the works, and *vice versa*. Personal observation leads me to think that the operatives referred to in this memorandum took on an average somewhat less than an hour each way, though I have no exact statistical data on the subject. There was an efficient tram service at their disposal.

Women Engaged in Light Labour.

14. In the next type of munition work to be described, the operatives were milling a screw thread on the fuze bodies. This necessitated their standing at semi-automatic machines, where they removed one fuze body and inserted another every minute or so. The requisite muscular effort was moderate and simple in character, and took up only about a fifth of the total time required for the operation. For the remaining four-fifths of the time the operative had nothing whatever to do, and so the call upon her attention and her muscles was very much less than that experienced by the operatives previously described. The output of 21 women was investigated over a similar statistical period, but it seems unnecessary to quote the results in full. The average records adduced in Table IV show that the hourly output varied in the same direction as that of the fuze-turning

Table IV.—21 women milling a screw thread.

Statistical period.	Average hours of actual work.	Average hours of broken time.	Average (relative) hourly output.	Hours × output.
5 weeks preceding Christmas (November 15—December 19)	67·4	4·4	100	6,740
2 weeks at Christmas (December 20—January 2) ...	44·7	3·5	98	—
3 weeks after Christmas (January 3—January 23)	63·7	3·0	106	6,752
4 weeks later (January 24—February 20)	53·1	2·6	104	5,522
8 weeks later (February 21—April 16)	59·3	3·6	109	6,463
2 weeks at Easter (April 17—April 30)	39·4	2·7	108	—
3 weeks after Easter (May 1—May 21)	59·8	2·6	112	6,698

operatives, but to a very much more limited extent. In the three weeks after Christmas it was only 6 per cent. greater than in the five weeks before it, and since the average hours of work were somewhat shorter, the total output remained practically unchanged. A considerable reduction of working hours did not lead at first to any improvement of hourly output, but this established itself after four weeks, and was maintained at a steady level during the next eight weeks. In that the average excess of hourly output amounted only to 9 per cent. above that of the pre-Christmas period, the total output became reduced to 4 per cent. *below* it. However, in the three weeks after Easter the hourly output improved a further 3 per cent., so that the total output reached to within 0·6 per cent. of the pre-Christmas value. Probably the best number of hours is something between the limiting values investigated, or about 62 hours, for if the output of 109 per hour were maintained over this time, the total output would work out at 6,758, or slightly above that of the pre-Christmas period.

Men Engaged in Heavy Labour.

15. The labour assigned to male munition workers is, as a rule, considerably heavier than that assigned to women, but making due allowance for the greater strength and endurance of the man, we

find that his output is similarly affected by a reduction in the hours of labour. One of the most fatiguing types of munition work so far investigated by me is that of "sizing." In the sizing of fuze bodies the article is usually subjected to four separate operations, in each of which it is clamped to a small fly-wheel and handle, and is screwed through a steel tap so as to cut a screw thread on it. The operations require no manual dexterity, but they are a great and continuous strain on the muscles of one arm and shoulder, and to a less extent on those of the back. The operatives seldom use both arms, as they prefer to keep the "screwing" hand dry, and use the other one for picking up the oil-covered fuze bodies. The output of a group of 27 operatives was investigated, and the mean results are given in Table V. The hours of labour were always shorter than

TABLE V.—27 men sizing fuze bodies.

Statistical period.	Average hours of actual work.	Average (relative) hourly output.	Hours × output.
6 weeks preceding Christmas (November 8—December 19)	61·5	100	6,150
2 weeks at Christmas (December 20—January 2) ...	38·3	89	—
6 weeks after Christmas (January 3—February 13) ...	51·1	109	5,570
8 weeks later (February 21—April 16)	55·4	122	6,759
2 weeks at Easter (April 17—April 30)	41·0	112	—
3 weeks later (May 1—May 21)	56·2	124	6,969

those worked by the women. They never exceeded 71 hours in any one week, and seldom included Sunday labour. The hourly output showed a marked drop during the Christmas fortnight, and a considerable rise (to 118) for the first week after this fortnight, but the average output during the six weeks after Christmas was only 9 per cent. greater than that of the pre-Christmas period, in spite of the fact that the weekly hours of labour were 10·4 shorter. Evidently the operatives took a long time to adapt their rate of production to the shorter hours, for the hourly output subsequently averaged 22 per cent. in excess of that of the pre-Christmas period. This caused the total output to be no less than 10 per cent. greater, and it is probable that even this figure does not represent the full effect of reducing the hours of labour, for after Easter the hourly output improved a further 2 per cent., and the total output was increased to 13 per cent. above that of the pre-Christmas period. However, a part of this improvement may have been only the temporary effect of the holiday. The week February 14—20 is omitted, as the operatives worked only 41 hours owing to shortage of material.

16. The broken time is not quoted in the above table as the nominal hours of labour were rather uncertain. Moreover, the operatives appeared to have had some freedom in selecting their own hours of work. The plan adopted in calculating the weekly hours of actual work was different from that observed in the other data quoted in this memorandum, for all weeks were included in which 20 hours or more were worked. The reason of this change was that these sizers, though they were absent altogether for only 1·8 per cent. of the weeks included in the statistical period dealt with, were in the habit of putting in short weeks of 40 hours or less with some frequency. If only those operatives who put in 45 hours or more had been included, the average weekly hours of actual work would have come to about two hours more than the figures quoted in the table.

17. The operatives engaged in sizing fuze bodies were all full-grown men, but certain other sizing operations were performed by youths. The output of one of these groups may be quoted, but in that it concerns only nine operatives, the data are not so reliable as those just recorded. The youths, 14 to 17 years of age, were sizing steel base plugs, and from Table VI we see that their hourly

TABLE VI.—9 youths sizing base plugs.

Statistical period.	Average hours of actual work.	Average (relative) hourly output.	Hours × output.
5 weeks preceding Christmas (November 15—December 19)	68·3	100	6,830
2 weeks at Christmas (December 20—January 2) ...	46·3	106	—
4 weeks after Christmas (January 3—January 30) ...	70·3	116	8,155
11 weeks later (January 31—April 16)	57·0	142	8,094
2 weeks at Easter (April 17—April 30)	42·1	135	—
3 weeks later (May 1—May 21)	60·9	155	9,440

output was 16 per cent. greater in the four weeks after Christmas than it had been before, in spite of a slight increase in the hours of labour, whilst it was no less than 42 per cent. greater in the 11 subsequent weeks when the hours of labour were reduced from 70·3 to 57·0. In consequence, the total output attained a value 19 per cent. in excess of that of the pre-Christmas period. Even this value does not represent the full effect of the reduced hours of labour, for in the three weeks after Easter the hourly output was 55 per cent. above that of the pre-Christmas period, and the total output 38 per cent. above it. Such results are so astonishing that one is naturally inclined to doubt their validity, but there appears to be no reason for denying their substantial accuracy. The boys must have been seriously overworked by the long hours, and hence the 8 to 12-hour reduction of the working week accelerated their rate of production much more than did the 6-hour reduction accelerate that of the men "sizers."

Men Engaged in Moderately Heavy Labour.

18. Typical examples of moderately heavy labour are found in shell-making, and all the data described in this section relate to the output of 3″ shrapnel shells. One of the most important and lengthy of the operations is that known as "boring the powder chamber." This operation is performed on capstan lathes provided with three sets of boring tools, and it requires considerably more muscular energy than that involved in turning fuze bodies, though not so much as in sizing. At one shell factory where the male operatives were being largely replaced by women, I was informed that though the women attained a good output in most operations, they produced only about half as many shells as the men did in this particular operation, since they had not the necessary strength.

19. The data in Table VII concern the output of 23 operatives, all of whom had been four months or more at the process previous to the statistical period recorded. During these months they

Table VII.—23 men boring the powder chamber.

Week ending	Weekly hours of actual work.	Hours of broken time.	(Relative) hourly output.	Hours × output.
November 7	48·5 } 47·8	1·0 } 1·7	100 } 100	4,780
„ 14	47·1	2·4	100	
„ 21	59·5 } 59·7	4·5 } 3·1	107 } 100	5,970
„ 28	60·5	3·5	98	
December 5	59·1	1·4	94	

worked at first for 53 hours per week, and subsequently for 49½ hours, and had attained their maximum output for these particular hours of labour. When their hours were suddenly increased to 64 per week (seven hours on Sunday), we see that they maintained their hourly output for three weeks with very little diminution. After this time there was a shortage of material at irregular intervals, so the output data were rendered valueless for statistical purposes, but even if the hourly output had fallen considerably lower, the total output would still have remained higher during a 60-hour week than during a 48-hour week.

20. An important operation is to "finish, turn and form" the shell, which consists in taking off a fine turning, and afterwards filing down the shell. This operation probably needs the expenditure of about as much muscular energy as that of turning fuze bodies. The data in Table VIII show the

Table VIII.—22 men, finishing, turning and forming 3-inch shells.

Week ending	Weekly hours of actual work.	Nominal hours of work.	Hours of broken time.	(Relative) hourly output.	Hours × output.
August 29	62·0	64	2·0	98	
September 5	64·1 } 60·3	65	0·9 } 1·0	100 } 100	6,030
„ 12	51·6	52	0·4	101	
„ 19	63·4	64	0·6	101	
„ 26	52·3	53	0·7	105	
October 3	39·0	39	0·0	112	
„ 10	51·2	52	0·8	112	
„ 17	53·0 } 51·8	53	0·0 } 0·8	118 } 114	5,905
„ 24	51·2	53	1·8	112	

output of 22 men who had been engaged at this work for 10 weeks, on an average, previously to the statistical period dealt with.

21. The hours of labour in the immediately preceding week had been 64, but before that they had been 49 for three weeks, preceded by 64 or more for seven weeks. We see that, on an average, the hourly output during the last three weeks recorded in the Table, when the hours of labour averaged 51·8 hours, was 14 per cent. greater than in the first four weeks when they averaged 60·3 hours. It is probable that a portion of this improvement was due to increased skill of the operatives, who were found to require three or four months' experience before attaining their maximum output, but assuming that the whole of the improvement was the direct result of the reduced hours of labour, the total output is still less for the short hour weeks than for the long ones. The time-keeping was extremely good, and suggests that the operatives could easily stand the 60-hour week, for not only was the broken time one hour per week or less, but during the 60-hour period recorded the operatives were never absent for a whole week, and they put in only 4 per cent. of short weeks. It should be mentioned that in calculating broken time, the 45-hour limit referred to previously was retained for operatives working 58½ hours or more per week, but with operatives working a nominal 52 hours only those were excluded who put in less than 40 hours of actual work, and with operatives working a nominal 49½ hours, only those who put in less than 38 hours of actual work.

Men and Youths Engaged in Light Labour.

22. In the operation known as "rough turning," the rough shell is turned approximately to size. During four-fifths of the time required the operative merely watches the lathe, so the labour

is very much lighter in type than that previously described, and resembles that required for milling a screw thread on fuze bodies. The hourly output of 18 men was investigated, and was found to be constant within the limits of chance error, whether they were working 49, 53 or 64 hours per week. For instance, on changing from a 49½-hour to a 64-hour week, the hourly output during three consecutive weeks was 100, 102 and 101 on that of the preceding weeks taken as 100. Again, when the 20 operatives of a permanent night shift had their hours increased from 47½ to 53½ for one week, and then to 67 hours for two weeks, their output was 99, 97 and 96 in the three weeks respectively, that of the preceding weeks being taken as 100. There can be little doubt, therefore, that these operatives could have worked longer weekly hours than 64 or 67 without greatly diminishing their hourly output, and so have attained a greater total output. This conclusion is strongly supported by the data for youths which are now to be recorded.

23. The youths, 15 to 18 years of age, were engaged in boring out the top caps of fuzes by means of semi-automatic machines. About four times a minute they unclamped one cap and clamped in another, these two clampings together occupying less than two seconds. For the rest of the time they stood at their machines doing nothing. From the average data recorded in Table IX, which concern

Table IX.—17 youths boring top caps.

Statistical period.	Average hours of actual work.	Average hours of broken time.	Average (relative) hourly output.	Hours × output.
5 weeks preceding Christmas (November 15—December 19)	75·6	2·9	100	7,560
2 weeks at Christmas	50·0	2·7	106	—
6 weeks after Christmas (January 3—February 13)	70·9	4·6	106	7,515
8 weeks later (February 21—April 16)	59·4	4·4	108	6,415
2 weeks at Easter (April 17—April 30)	40·8	4·6	95	—

the output of 17 operatives, it will be seen that before Christmas they averaged 75·6 hours per week of actual work out of the 78½ nominal hours. In the six weeks after Christmas their hourly output went up 6 per cent., but in that they averaged 4·7 hours a week less than before, their total output was slightly diminished. The output of the week February 14-20 is omitted as there was a shortage of material, but in the next eight weeks, when the average hours were reduced to 59·4 per week, the output rose another 2 per cent. This rise by no means compensated for the considerable reduction in working hours, so we find that the total weekly output was actually 15 per cent. less than in the pre-Christmas period.

24. It seems probable, therefore, that to attain maximum output 70 hours or more per week of this light labour must be worked. It will be seen from the Table that when the operatives were working over 70 hours per week their broken time was not excessive. Moreover, they put in only 2·0 per cent. of short weeks and 3·6 per cent. of absent weeks on an average, so the long hours did not appear to affect their health.

Comparison of Results.

25. The various types of labour investigated may conveniently be divided into five, viz., very heavy, heavy, moderately heavy, light and very light. Of these types the "very heavy," such as sizing fuze bodies, and the " heavy," such as boring the powder chamber, are not well suited to women. On the other hand, the " light " type, such as boring top caps and rough-turning 3-inch shells, had better be confined to women, as it is waste of muscle to appropriate them to men, or even to youths. Very light types of labour such as sedentary gauging operations should evidently be confined to women and girls.

26. We have seen that for men engaged in the very heavy labour of sizing fuze bodies the maximum hours of actual work appeared to be 56 or less per week; for men engaged in boring the powder chamber and in turning and finishing shells they were probably 60 or rather more, whilst for men rough-turning shells and for youths boring top caps they were probably 70 or even more. On the other hand, for women engaged in the moderately heavy labour of turning fuze bodies the maximum hours were 56 or less, whilst for women on the light labour of milling a screw thread they were rather over 60 hours. In so far as time-keeping is a criterion, women and girls on the very light work of gauging fuzes appeared to stand even 76 hours fairly well, but it is more than likely that their actual output was little, if any, greater than when they were working 64 hours, and so it is probable that this figure should be regarded as their maximum.

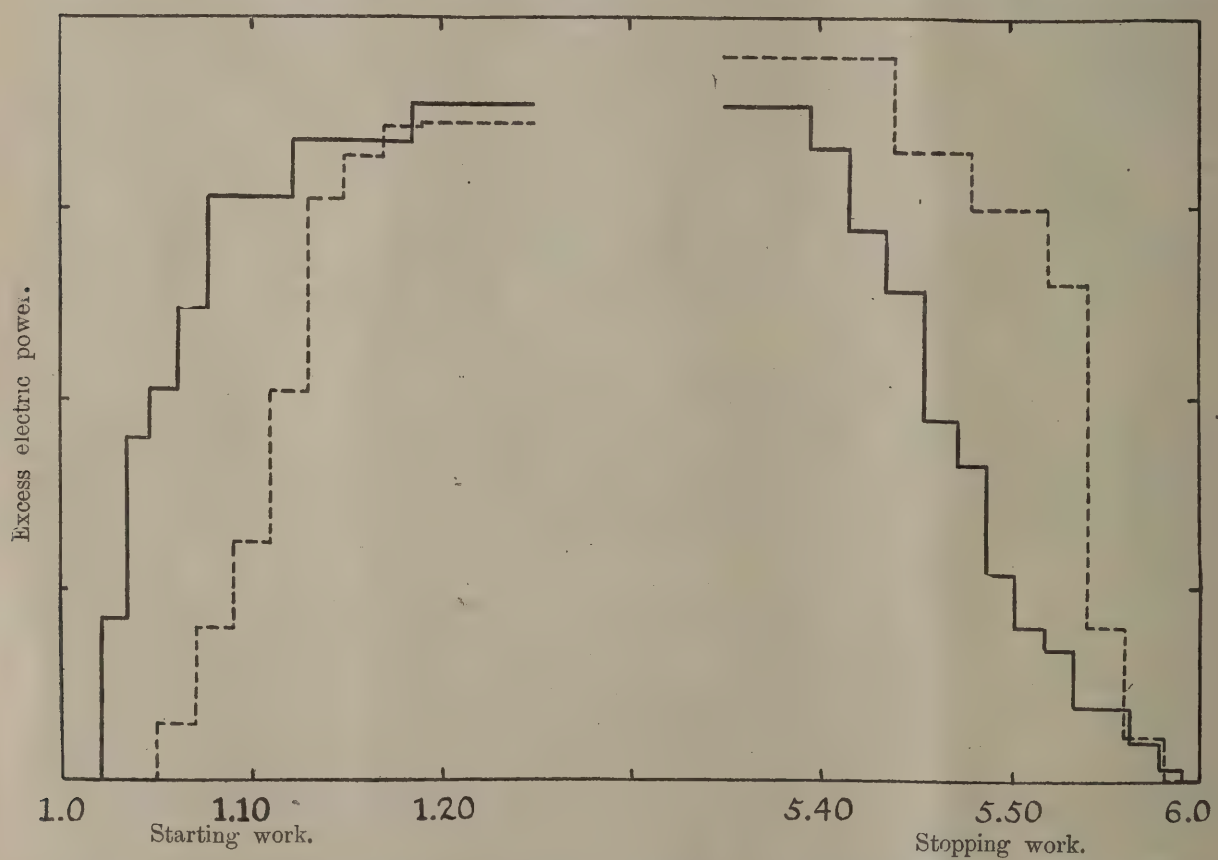
27. It must be realised that all of these data are provisional, but they clearly justify the conclusion that the hours of labour should be varied between wide limits according to the character of the work performed. This obvious fact is not realised by many managers of munition works, and the tendency is usually towards uniformity of hours for all types of labour and for workers of both sexes. The data adduced suggest that not only are women unsuited to the heavier types of work, but that even when engaged on the moderate and light types they are unable to stand such long hours as the men. Several sets of operatives, both male and female, were kept under close observation for many days in order that their powers of application might be investigated. Men engaged in boring the powder chamber and in turning and finishing shells were found, almost without exception, to stick to their work with admirable persistence, and it was very seldom that they rested even for a minute. On the other hand, women engaged in turning fuze bodies rested for times which in aggregate amounted to 1½ hours out of the 12-hour day, and over an hour out of the 10-hour day, in addition to the hour or so of compulsory rest required for attention to their lathes at the hands of the tool-setters.

About half an hour of the voluntary rest pauses occurred on starting and stopping work, but much of the remaining hour or half hour was probably due, not to idleness on the part of the women, but to fatigue, and to an instinctive knowledge that short rest pauses helped to prevent undue fatigue. Still, it would have been better if these pauses and the times lost in starting and stopping had been curtailed by, *e.g.*, half an hour a day, and the women had been permitted a corresponding reduction in their weekly hours of labour.

28. It is to be borne in mind that all of the times mentioned are the *maximum* hours of actual work, supposing that a maximum output is required regardless of cost of production. They necessarily impose a great strain on the operatives, and there can be no doubt that in many instances the strain was too great to be borne, and that the operatives had to drop out altogether. That is to say, the data quoted relate to the fittest who were strong enough to survive in the struggle, and not to the general mass of workers of all classes who tried their hand at munition work. It is almost impossible to discover the extent of this weeding out, but it is inevitably considerable. Hence the *best* hours of work, suited for peace times, are in every case considerably shorter than those mentioned, though the principle of graduating the number of hours of labour to the type of work performed still holds with undiminished force.

Further Points for Consideration.

29. Though stern necessity may compel long hours of labour on the part of many munition workers, it is evident that, provided maximum output is maintained, the shorter the times for which they are shut up in the factories the better their chances of health and happiness. Hence everything possible should be done to speed up the rate of production so far as this can be done without making an extra call upon the physical energies of the operatives. Though I have no intention on the present occasion of discussing the matter in detail, I wish to suggest two simple plans of appreciably increasing the rate of production. The first depends on greater promptness in starting work. A few concrete instances will bring home the importance of this point, at least in some munition factories. In most works the motive power is electric, and in some the power supplied to each section is registered by a separate watt-meter. The machinery is started running shortly before work begins, and as the operatives get going, one after another, the power consumption steadily rises to a maximum, which is attained when all the operatives have started. By means of these power records the rate of starting and stopping work can readily be ascertained in many instances, though not in factories



where time is spent in a preliminary collection of necessary tools and material, and in their adjustment. The accompanying figure records the increments of electric power over that required to drive the free-running machinery, on starting and stopping the afternoon spell of work. The continuous line represents the power supplied to a large shell shop which turned out 30,000 3-inch shrapnel shells per week. We see that the power supplied started mounting up two minutes after starting time, and reached half its full value in four minutes. The dotted-line curve, representing the power supplied to a section of 200 women turning fuze bodies, did not begin to rise till five minutes after starting time, and did not attain half its maximum value until 11 minutes after starting time. In other words, the operatives wasted about seven minutes more in starting than did the operatives in the shell shop, most of whom were men. On the other hand, the fuze-turners finished more strongly than the shell shop operatives, as can be seen by comparing the two curves given on the right side of the figure, and it was found that both sets of operatives lost, on an average,

about the same aggregate of time in starting and finishing during the course of the whole day, viz., 34 minutes. The shell shop operatives did not start much more promptly than the fuze-turners in the morning, partly because there was more delay in the arrival o their material, but in spite of this, if the operatives of both shops had started equally promptly, and finished equally strongly, nine minutes out of the 34 would have been saved. There was no inherent reason why work should have been started promptly in one shop and not in the other. It was merely a custom of the particular shop, and even then the custom was not a fixed one. A series of meter readings of the women's section were taken for several days before and after the Easter holiday, and nine days before the holiday the average amount of time wasted in starting after dinner was found to be 11 minutes; two days before it was 14 minutes. Two days after the holiday it was 16 minutes; three days after it was 15 minutes; and five days after it was 12 minutes. That is to say, it increased with the slackness of the operatives caused by the immediate approach of the holiday, and still more with their post-holiday lassitude.

30. There can be no necessity for the waste even of 25 minutes in starting and finishing work. Ten or 15 minutes should be an ample allowance, and the 20 minutes thereby saved could be deducted from working hours without any reduction of output. At one large works the manager informed me that he made a point of going into the various shops at starting time, and seeing that the operatives began work promptly. In this way a considerable amount of time was saved.

31. The other method of speeding up production on which I wish to lay stress has already been referred to in an earlier memorandum (No. 7). It consists in the regulation of rest pauses. The custom in many munition works is for the operatives to work for a spell of five hours, and then, after an hour's interval, for another spell of four and a half to five hours. Such spells are undoubtedly too long in many types of munition work, but if a second break is introduced in the working day, much extra time is lost in starting and stopping work. If the operatives are left to themselves, they take rests at irregular and often unsuitable times. Hence it would be much better if the rest pauses were chosen for them. For instance, a ten-minute break in the middle of the morning and afternoon spells, during which the operatives remain at their machines, but take tea or other nutriment brought them by boys or by travelling canteens, has been found a valuable aid to output in some munition works. Some types of work need longer and more frequent rest pauses than others, and the best times can be determined only by experiment. After being fixed they should be made compulsory, and rest pauses at other times be checked so far as possible.

THE COMPARATIVE EFFICIENCIES OF DAY WORK AND NIGHT WORK IN MUNITION FACTORIES.

CONTENTS.

1. Civilised nations have recognised that except in case of necessity or in times of great emergency night work is undesirable; but the sudden and urgent demand for output which the present war has brought with it has necessitated much night work for all classes of operatives.

2. Many general considerations would require examination if the whole question of night work in industries were under review, such as:—

(1) The remotely injurious effects of permanent night work, effects which are not manifested until after a long latent period.

(2) The disturbance of normal home life; and

(3) The undesirability of hours which necessitate the passage of young women through the streets of large towns during the night.

The moral side of this question is of undoubted importance, but the Committee have before them no facts, either collected by their investigators or published elsewhere, which can be made the basis of useful discussion. The following remarks by Professor Loveday are, however, of interest. He reports that a certain firm had decided to discontinue a three-shift system, and that "one reason is the extremely bad time kept in the night shift. In bad weather, with darkened streets, many women seize any excuse for not going down to factories at 10 p.m."

Although of extreme importance when night work is envisaged as a permanent feature of our civilisation, these considerations do not assume the same place when we are dealing with an admittedly temporary state of things.

3. The Committee, however, is avowedly taking a short and not a long view of the subject, and is solely concerned with the factors which are of importance during the present emergency. Thus, to take an extreme case, were it to be shown that the efficiency of night work, measured in terms of output, were but a small fraction of that of day work, it would not necessarily follow that night work should be discontinued. If the night workers produce *any* appreciable quantity of manufactured articles, their employment increases the absolute supply of munitions, and is therefore justifiable; provided always that the lower efficiency is not an indication of such damage to health as must, in the

near future, involve a diminution of the already limited supply of available labour, and therefore, in the end, a diminution of gross output before the necessity for a maximal supply has passed away. Conversely, a high degree of relative efficiency in night shifts would not justify the system if it were purchased by a rapid exhaustion of the health and strength of available workers.

4. Judgment on this restricted aspect of night work must be based upon a knowledge of both the comparative output-efficiency, and of the prevalence of invalidity, sickness and bad timekeeping among night and day workers.

5. In view of the grave objections which have been urged against night work on medical and physiological, as well as on purely economic, grounds, especially in the case of women, the Committee became anxious as to the possibility of grave results to health ensuing with diminished output as a consequence. They therefore some time ago instructed investigators to study this closely. This study seemed the more urgent as no accurate data were available upon which conclusions could be based as to the least harmful system of employing persons by night, and the Committee in an earlier memorandum (No. 5, Section 17) found it necessary to leave the matter *sub judice*.

PREVIOUS PHYSIOLOGICAL OBSERVATIONS.

6. The temperature of the human body is not constant, but is known to exhibit a distinct cycle during the 24 hours, the maximum appearing between 4 p.m. and 8 p.m., and the minimum between 2 a.m. and 6 a.m. The difference, although the actual maxima and minima are not the same in different persons, may be said to be between 1 and 2 degrees (Fahrenheit). The natural explanation of this cycle is that it reflects the diurnal variations of bodily combustion, in particular that going on in the muscles; and this surmise is borne out by numerous observations, such as those of Simpson* and Johannsson† to the effect that absolute muscular rest in the fasting condition greatly reduces the amplitude of the daily variation. Gibson‡, Osborne§ and Simpson have also shown that the temperature cycle conforms to local time; that is to say, if a person's day maximum has been found to occur at 6 p.m. (New York time) in New York, it still occurs at 6 p.m. (Greenwich time) when he comes to Glasgow, and not at 1 p.m., as it should were the rhythm independent of bodily activities. It ought, therefore, to follow that the temperature cycle in a man who works at night and sleeps by day is reversed, the maximum appearing in the early morning and the minimum in the early evening. Some observers, such as Jaeger, who reported on Army bakers, claimed that the expected reversal really occurred; but their methods were inexact, and the careful observations of Benedict‖ led to the conclusion that the curve was modified, but not reversed; rest and sleep during the day lowered the temperature, but work during the night did not appreciably raise it.

This result is susceptible of two explanations. Either the cause of the diurnal rhythm lies deeper than variations of metabolism, or, in a society the habits of which are based upon the allocation of daylight hours to work and hours of darkness to rest, the minority which strives to change its habits is practically unsuccessful. That the second explanation is the true one has been demonstrated in two ways. A colony of monkeys can be subjected to much more rigid discipline than can human beings, and the routine of its existence can be completely inverted. Simpson and Galbraith¶ performed such an experiment, and found that in monkeys, kept active at night and allowed to sleep in light- and sound-proof cages by day, the temperature rhythm was completely reversed.

The second proof is furnished by the observations of Linhard, who was medical officer to the Danish Arctic Expedition of 1906-1908. During the Polar night all work, practically speaking, is done indoors and by artificial light. When the lamps are put out, which is done at a fixed hour determined by the commander, it is night; when they are relighted it becomes day. External temperature changes are slight in extent. An experiment was carried out by delaying bedtime once four hours and then eight hours, and by inserting an extra meal, so that in two days a complete reversal of "night" and "day" was effected. More than half the 26 members of the party felt just as usual so soon as the transition had been accomplished; by the end of five or six days, only a few were a little indisposed to work, not sleeping so well at "night" and becoming sleepy at odd times of the "day." The function which was changed with the utmost difficulty was the time of defæcation, and in some it took about a week before this occurred at the "normal" time. All the temperature curves taken pointed to reversal of rhythm, a delay of adaptation being found in the cases of those few who experienced some difficulty in at once adapting themselves to the changed conditions.

These results are of considerable practical importance. They show clearly, at least for the period of the experiments, that the accustomed routine of day work and night rest can be reversed, without injury to health or efficiency, but they also show that a necessary condition is that the workers must either be endowed with more than common powers of self-control, to enable them to surmount the temptation to make the best of both worlds, or must live under strict discipline. The evidence collected by the Committee's investigators places many permanent night workers, whether judged by the test of output or of lost time, in an unfavourable light in comparison with day workers, and the explanation is probably contained in the preceding sentences.

---

* Trans. Roy. Soc., Edin. XLVIII (Part II), 1912, page 231.
† Skand. Archiv. für Physiolog. VIII, 1898, page 85.
‡ American Journ. Med. Sc., 1905, page 1,048.
§ Journ. Physiology (Proc. Phys. Soc.), 1908.
‖ American Journ. Physiology, XI, 1904, page 143.
¶ Trans. Roy. Soc. Edin., XLV (Part I), 1905, page 65.

METHODS OF NIGHT WORK.

7. The main distinction is between what may be termed *continuous* night work, in which employees work by night and do not attend the shop at all in the daytime, and *discontinuous* night work, in which the employees pass into the night shift at regular intervals, generally every other week. Between the extremes of entirely continuous night work and regular weekly alternation, all variations may exist and many have been found in practice.

FEMALE LABOUR.

I.—Output.

8. *Discontinuous Employment of Women in Night Shifts.*—The first data to be considered* were provided by Dr. H. M. Vernon, and this material is of rather special importance, because Dr. Vernon was able to compare the effect of different systems in the same factory. The particular data relate to girls engaged in a cartridge factory, and as several of Captain Greenwood's analyses also refer to cartridge work, a portion of Dr. Vernon's description of the processes is here given:—

> "In the making of small-arm ammunition the brass cartridge cases pass through 16 main processes, in addition to the annealings, whilst the bullets pass through 11 processes. (*Note.*—The exact number is not the same in all factories, certain operations being combined.) The operations are carried out almost exclusively by women and girls, and represent the acme of monotonous repetition work, for no individual operation takes more than about a second to perform. In about half of the cartridge case operations the rate of production is to some extent limited by the nature of the machinery, for in four of the 'draws' and in the subsequent rectifying and piercing processes the cartridge cases are inserted one by one into holes at the peripnery of a horizontal wheel, which slowly jerks onward about twice a second. As most of the operatives are able to fill in nearly all of the holes, it follows that the quickest of them are unable to reap the full benefit of their quickness, and so the range of variation in the output of the quickest and slowest workers is somewhat smaller than in most of the other operations."

There are also, as Dr. Vernon points out, some differences in the demands made upon muscular power on the one hand and alertness on the other. "Head-trimming," for instance—an operation in which the cartridge case is inserted in a machine operated by pulling a lever—requires a fair amount of muscular exertion. In "mouth-reamering" the girls take up a handful of cartridge cases and slip them on and off a rotating taper hand-mill, or roughened spindle, at the rate of about three a second. This requires more alertness and quickness than the other operations. In a few of the processes, such as "countersinking" and "mouth-boring," the pace is set by the operator, for the machine is not acting until she presses a lever or pedal. (These two operations did not come within the scope of Dr. Vernon's inquiry.)

9. Dr. Vernon's data relate to 29 women on "second draw," 39 on "head-trimming," 24 on "second cut-off" (sometimes called "edging"), and 20 on "reamering." They worked on the discontinuous system, changing weekly; the average hours worked were 51·7 by day, 55·9 by night, and the period of observation was 22 consecutive weeks from 3rd January, 1916.

Taking the mean hourly production over the whole period to be 100, Dr. Vernon found means for the four sets on day shift of 99, 101, 100, 99, and for the same workers on night shifts 101, 99, 100, 101. If each night average be divided by the corresponding day average and the result multiplied by 100 to render the figures comparable with those of Captain Greenwood—who has usually adopted such a ratio as a comparative figure—we have 102, 98, 100, 102. Multiplying each of these figures by the number of girls concerned in each, adding the results together, and dividing by the total number of girls, we reach 100·1 as the mean of the whole series, *i.e.*, perfect equality between the mean hourly outputs. This equality is not, taken by itself, a proof that night work produces no injurious effects upon output. Thus, were night work harmful, its effects might react upon the subsequent day work, so that the general average was lowered, although the ratio between the day and night production might be that of equality. Dr. Vernon was able to test this point by comparing the performances of girls on continuous or discontinuous day or night work in the same factory, and found that the comparison was not unfavourable to the discontinuous system with weekly changes. The details of this investigation will, however, be more conveniently considered in the section devoted to the study of continuous night work.

10. The above investigation relates to discontinuous night work with a weekly change. Dr. Vernon also investigated the effects of a fortnightly change in the case of 41 women engaged on bullet operations. The period available for study was shorter, and the data complicated by irregularities in the supply of material to the night shift, but Dr. Vernon concluded that the hourly output was probably somewhat better in the night shifts than in the day shifts.

11. He secured more extensive data in the case of women turning aluminium fuze-bodies on capstan lathes. Two groups were available, one of them—21 in number—for two four-week periods;

---

* The information collected by the Committee's various investigators of which use is made in this memorandum has been embodied in several reports, frequently of an elaborate character, which discuss in detail many problems receiving only a passing reference in this memorandum. The Committee desire to state that the extracts given do not always completely represent the amount of work performed by the investigators, or in some cases the precise deductions drawn by them.

the other—26 in number—for three four-week periods. The average output in the second week of each fortnight on day shift was 3% greater than in the first week, and that in the second week of each fortnight of the night shift 5% less than in the first week, but the average output in night shifts was 7% higher than that of day shifts. Dr. Vernon writes:—

> " The probable reason of this unexpected excess of output is an interesting and important one. It depended on the better arrangement of spells of work and rest pauses of the night shift. This shift usually worked six nights a week, from 6.30 p.m. to 10.30 p.m., from 11.30 p.m. to 3.0 a.m., and 3.30 a.m. to 6.30 a.m., or for spells of four hours, three and a half hours, and three hours, separated by breaks of one hour and half an hour. The day shift, on the other hand, usually worked from 7.0 a.m. to 12.0 noon, and 1.0 p.m. to 6.0 p.m., or for two spells of five hours each, except on Saturday, when they worked for spells of four and three-quarter hours and four and a quarter hours, and on Sunday, when they worked for two spells of four hours each. A spell of five hours is probably too long for almost any type of labour, and it was certainly too long for women engaged in moderately heavy lathe work. Careful observation shows that during working hours the women on day shift took voluntary rest pauses which amounted altogether to over an hour out of the ten-hour day, in addition to the hour or so of compulsory rest required for attention to their machines by the tool-setters. These rests were taken at irregular and often unsuitable intervals, whilst the night-shift workers were compelled to stop work at times which divided the working hours into spells of suitable duration.

12. In face of these peculiarities, it would not, as Dr. Vernon points out, be logical to regard the results as demonstrating the superiority of fortnightly changes of shift over weekly changes, and his results for the latter system have been shown to indicate a practical equality of hourly output between the day and night shifts.

13. Captain Greenwood has furnished the Committee with five sets of data, having reference to the discontinuous night work of women. Three of these relate to cartridge factories, one to lathe work on 18-pounder shell fuzes, and one to certain operations in the manufacture of 9·2-inch naval shells. These data have an advantage over those supplied by Dr. Vernon in respect of numbers of individuals studied, but they are inferior in that the length of period available for study was usually shorter, and the exact number of hours worked was not always recorded in the factory. The method of statistical comparison adopted in all but one of the series (for which the necessary particulars were unattainable) was to treat each individual worker separately. Her average hourly output by night was divided by her average hourly output by day, and the result multiplied by 100. The mean of the resulting percentage ratios was then taken to characterise the group, regard being had to its " probable error."

14. The first series consisted of 50 girls engaged on cartridge-case operations, observed through twelve weeks, from 8th April, 1916. The mean weekly hours worked were 52 in day and 55 in night shifts. The mean percentage ratio of hourly output by night to hourly output by day was $101{\cdot}5 \pm 0{\cdot}5$*, *i.e.*, there was no significant difference. Even the apparent increase of 1·5%, however, slightly exaggerates the difference; for the outputs improved on the average from the beginning to the end of the period under observation to the extent of rather less than 0·5% per week. As the series begins with a day week and ends with a night one, it would be expected that, if the conditions were identical, the night production would be slightly higher, since, on the average, the night work is a week later than the day work. Deducting 0·5% from the 101·5%, we reach a value which is within a fraction of Dr. Vernon's. This series, therefore, is completely concordant with the previous one.

15. The second of Captain Greenwood's series is also derived from a cartridge factory, and refers to 11 bullet shop operatives, observed from the week ending 29th April down to the week ending 15th July, and 27 workers in the case department, observed from the week ending 23rd January to the week ending 2nd April. The average number of hours worked were, for both the bullet sample and the case sample, 55 by day and 49 by night. The average for the bullet workers are not typical of the ordinary conditions, as the first week of the period observed was broken by holidays. Further, the case workers changed weekly, but the bullet workers, with one or two exceptions, worked every third week on night shift. The mean percentage ratio proved to be $89{\cdot}3 \pm 0{\cdot}7$ for the case workers and $95{\cdot}9 \pm 1{\cdot}7$ for the bullet shop workers. In commenting on these results, Captain Greenwood points out that the second figure is not, having regard to its probable error, significantly different from 100, and that the former is based upon observations in the winter months, a fact which is apparently of some importance, as in another series, which will be considered later, the same relative disadvantage of night workers in the winter is found. This observation indicates that in this factory the hourly output in night shifts is somewhat lower than in day shifts.

16. The third series of data, from a national factory producing cartridges, is, so far as numbers of individuals are concerned, much more extensive, but the period of observation is short, only extending from the week ending on 6th June to that ending on 11th July, 1916. In all, the outputs of 339 girls

---

* The quantities to which are prefixed the sign $\pm$ allow for " Probable Errors," and measure the reliability of the averages to which they refer. Thus if, on *a priori* grounds we should expect a certain average to be, say, 100, and we actually find on trial of a limited number of measurements that the average is, say, 98 ± 2, the observed value being only less than the expected value by a quantity equal to the former's probable error cannot be said to differ significantly from the expected value. The limit conventionally chosen is three times the probable error, and averages which do not differ by as much as three times the probable error of their difference are not deemed to differ " significantly."

distributed over 14 operations were studied. The day and night shifts were of equal length, viz., 10 hours 10 minutes. The mean percentage ratio was found to be 98·7 ± 0·3, or slightly less than 100%. The ratios for the separate operations varied from 104·8 ± 1·2, in the case of the " first draw " (29 girls employed), down to 94·9 ± 0·9 in the case of " mouth-boring " (48 girls employed), *see* Table I. This variation is an interesting confirmation of a surmise of Dr. Vernon's. After noting that his results pointed to the discontinuous system with weekly changes being the best, Dr. Vernon wrote:—" It is to be remembered that cartridge-making is more monotonous than almost any other type of munition work, and so the favourable influence of working alternate weeks of day and night shift may be due partly to the fact that it offers a slight relief from this intense monotony." As stated above, the drawing operations are typical instances of monotonous processes, while " mouth-boring," in which the operator can largely work at her own pace and is not forced or stimulated to maintain a particular rate by the machine, is somewhat less monotonous. In the former case we find no inferiority, and in the latter a definite inferiority of production by night shifts, in Captain Greenwood's data.

17. One further point is brought out owing to the large number of individuals in this series. In their memorandum on " Industrial Fatigue " (page 12, para. 10) the Committee wrote:—

> " Measurements of output must obviously be recorded at so much for each individual or for each unit group. The size of total output will be meaningless, of course, without reference to the numbers engaged. But it will also be important for proper management to take account of the output of particular individuals. This in many factory processes is easily possible, and when it has been done the results have shown surprising variations of individual output, which are independent of personal willingness and industry, and have generally been quite unsuspected by the workers and their supervisors before the test was made. Information so gained is valuable in two respects. Good individual output is often the result of escape from fatigue, by conscious or unconscious adoption of particular habits of manipulation or rhythm. Its discovery allows the propagation of good method among the other workers. In the second place, these tests of individual capacity (or its loss by fatigue) give an opportunity for a rearrangement of workers and their assignment to particular processes of work. Astonishing results, bringing advantage both to employers and employed, have been gained in other countries by the careful selection of individuals for particular tasks, based, not upon the impressions of foremen, but upon the results of experiments."

The method of this recommendation is applicable to the comparison of day and night work. In daily life we find that different individuals can work best at different times of day, and those who can control the arrangement of their working hours, many literary and some scientific workers, for instance, take advantage of the fact. Probably the same rule holds good for factory hands, and if so it might find expression in the existence of small numbers, whose outputs were very uneven, either greatly in excess by day or by night, of larger numbers showing smaller discrepancies, and of still larger numbers approximately equalising day and night outputs. The following Table II from Captain Greenwood's data shows that the expectation is fulfilled:—

TABLE I.

Night-Day Ratios.

Operation.	*No. of Girls.*	*Ratio.*
1st draw	29	104·8±1·2
2nd draw	22	101·7±1·3
3rd draw	19	94·3±1·4
4th draw	28	100·5±1·2
1st indent...	24	98·6±1·3
2nd indent	28	100·0±1·2
2nd taper	18	101·1±1·5
3rd taper	21	91·8±1·4
Heading	20	100·8±1·4
Piercing	21	95·7±1·4
Semi-annealing	18	96·4±1·5
Head turning	24	101·1±1·3
Trimming	19	101·5±1·4
Mouth boring	48	94·9± ·9
	339	
General mean		98·7
S.D.		9·2

TABLE II.*

Night to Day Ratio.	*Distributions. Observed.*	*Calculated.*
0–74	0·0	1·32
74–78	1·0	3·03
78–82	9·5	7·82
82–86	21·5	16·80
86–90	28·0	30·05
90–94	39·0	44·75
94–98	62·0	55·50
98–102	63·5	57·31
102–106	47·0	49·28
106–110	30·5	35·29
110–114	20·5	21·04
114–118	5·5	10·44
118–122	6·0	4·32
122–126	4·0	1·48
126–130	0.0	0·43
130–	1·0	0·12
Totals	339·0	338·98

* This table is to be read as follows:—The figures in the second column are the actually observed numbers of girls whose average hourly output when on night work was the percentage of their average hourly output on day work shown in column 1. For instance, 28 girls produced, when on night work, from 86 to 90% of their day-time output. The appearance in some groups of fractions is due to the occurrence of girls producing percentages on the limit of a group. Thus a girl whose night production was just 82% of her production by day would be entered as 0·5 in the group 78 to 82, and also as 0·5 in the group 82 to 86. (The third column is a redistribution of the frequencies in different groups on the assumption that the observations are adequately described by a certain symmetrical curve. The resulting distribution does not, of course, appear to be symmetrical, as the mean of the whole series does not happen to fall at the centre of any of the groups formed.)

The figures in the third column show the distribution which would be anticipated if the observations were symmetrically distributed above and below the mean value in accordance with a curve, which has been found to describe effectively many forms of anthropometric variations. The observed distributions in the second column agree very fairly with the calculated ones, and tested by exact methods the agreement has been found to be satisfactory. Clearly, there are appreciable numbers of individuals whose outputs differ greatly in the alternating shifts, and it is probable that some of these are unfavourably affected by the alternation, or fail, in some way, to adapt themselves to the varying conditions. The particular study of such cases might result in a general improvement of output by elimination of unsuitable individuals or amelioration of special conditions.

18. The next set of data was obtained by Captain Greenwood and Mr. S. H. Burchell from a factory turning out fuzes for 18-pounder shells, and refers to 68 girls engaged on semi-automatic operations, chiefly capstan-lathe operations. The system was discontinuous, with weekly change, and the period of observation from the week ending 9th January to the week ending 26th March, 1916. The full day-shift week was 56 hours, the full night-shift week 45 hours; the actual daily working hours of a full day shift were 9½, and of a full night shift 10½. The mean night to day ratio of hourly output was 101·3 ± 0·6, *i.e.*, in this series also there is no sensible difference between the rate of production at night or by day.

19. The last series of data concerning women, analysed by Captain Greenwood, was obtained by him and Mr. S. H. Burchell from a factory engaged in the manufacture of 9·2-inch naval shells. The period of observation was of 11 weeks, from 1st July, 1916. The organisation was into three eight-hour shifts, so that an individual would be in the third, or night, shift every third week. The system of records did not enable the investigators to obtain the outputs of individuals, and they were of opinion that the data were less reliable than those of the previous series. Six operations were investigated—"rough turning," employing approximately 54 women; "finish turning," with 17 workers; "boring," with 25; "basing and facing," with 9; "parting," with 16; and "radiusing heads," with 6. If the output of the morning shift be taken as 100, the relative outputs of the afternoon shift and the night shift for the whole period were:—

	Afternoon Shift.	*Night Shift.*
Rough turning	100·2	100·6
Finish turning	97·3	95·2
Boring	103·0	98·6
Basing and facing	106·1	103·4
Parting	100·2	101·3
Radiusing heads	102·4	96·2

The mean values (weighting each with the approximate number of workers involved, and dividing by the total number) are 100·9 and 99·5; in other words, there is no material difference between the outputs of the three shifts. This result falls into line with the majority of Dr. Vernon's and Captain Greenwood's series, but the nature of the material does not permit of any more detailed analysis.

20. Data have also been provided by Mr. P. Sargant Florence. Mr. Florence's chief series is derived from a cartridge factory, organised on the discontinuous system, with weekly change. The working hours, exclusive of meals, were 10 by day and 10½ by night; there was no Saturday night work, and the day work lasted 7½ hours; on Sunday it was 9½. In comparing the outputs of night and day shifts Mr. Florence adopted the following device:—"If the night output of any one week, from Wednesday to Tuesday, be compared with the day output, less that of Saturday, of the same week, there will be on each side of the comparison three days by one shift and three days by the other; the only correction required will be due to the six nights totalling 63 hours (66 before 6th October), the days totalling 57½ hours (10 × 5 + 7½ for Sunday)." Only full workers were considered, and the observations cover the four weeks from 31st August, 1915. It is not clear what the actual number of different *individuals* was, but it cannot have been less than 171, employed in different operations; no single operation, however, provides records for more than two weeks. Mr. Florence found that the night output was 95% of the day output for the whole series (the appropriate correction having been made for differences in the lengths of the shifts). If each operation is considered separately, and the mean of the separate ratios computed, this is found to be 94·2 ± 1·4. The range of variation within the series is very considerable, the ratio falling as low as 70 in one operation, and rising to 103 in another. The mean is lower than all but one of the previously considered series, but, having regard to its probable error, cannot be said to differ significantly from the rest. That this interpretation is the correct one is suggested by a further observation of Mr. Florence. He compared the gross outputs of the cartridge case department in the same factory, in two selected fortnights later in the year, and found that the percentage ratios (allowing as before for differences in length of shift) were 103·5 and 100·0. His observations may, therefore, be said to agree with those of the other observers.

21. Mr. Florence's next series is the outcome of a different class of work. This consisted in drilling and tapping small fuze parts on sensitive drilling machines. The processes concerned are less monotonous than the cartridge operations. The system is discontinuous, with weekly change; the hours are 10½ on day and 10 on night shifts, the weekly hours 56 to 58 for day weeks, 50 for night weeks. The following comparison was instituted:—The efficiencies of the operators, during seven weeks from 30th January to 12th March, 1916, were analysed, and all cases extracted where an operator worked more than 10 hours on a certain job during the days of one week, and more than 10 hours on the same job in the night shift of another week. The number of girls involved was 44, and the comparative efficiency of night work, in terms of day work, was 91·6%. A similar difference was found in the case of an intensive study of the outputs of two individual workers, viz., a reduction of

output to the extent of about 10% at night. In only one of the earlier series (*see* paragraph 15, page 29) was so great a difference found. The form in which Mr. Florence's data are presented makes it impossible to determine the error of sampling to which the average is subject, but assuming that the difference is statistically significant, it adds point to the remarks of Dr. Vernon cited on page 4 supra with regard to the possibility of the peculiarly monotonous nature of cartridge work having something to do with the equality of day and night outputs. In this connection some remarks of Mr. Florence are of interest. He writes:—

> " A personal visit to the cartridge case department at night showed that girls tend to drop straight off to sleep immediately their machine breaks down and they need no longer work. They would appear, indeed, to be continually on the verge of sleep, and yet the output is maintained at the day-shift rate. Apart from the fact that lengthy repairs to machines are not undertaken at night, and that there is then generally less interference from the staff with the course of work, the explanation of the paradox lies mainly in the nature of the work. . . . The operatives have only to fill a slot or reservoir with the material right end up; the machine does the rest.* The girls soon learn to ' automatise ' the movement required in filling, and can continue to execute them even when half asleep."

Since the operations just dealt with were less monotonous than the cartridge work, the result is in agreement with Mr. Florence's and Dr. Vernon's surmises. The explanation is not, however, sufficient to cover the whole of the facts. Both Dr. Vernon and Captain Greenwood found an equality, or even a slight superiority, of the night output in the case of fuze work, and although Dr. Vernon's explanation of his result as due to better arrangement of spells during the night shift may be accepted, no such interpretation covers Captain Greenwood's case. In the factory he dealt with no uninterrupted spell of day work exceeded four hours.

22. The last set of observations provided by Mr. Florence was obtained incidentally, and is of no great extent. It refers to six girls, engaged in drilling plugs, and observed for four weeks. and the nightly rate of output was found to be 90·7 of the daily rate. This result agrees with the last set of observations. and shows again an inferiority in comparison with most of the cartridge records. Mr. Florence attributed the difference to " the greater concentration required in lathe work, such as the above (*i.e.*, the operation in question), which is unofficially described as ' drill two key-holes and fix screw-holes.' The plugs are placed in position by eye under the two drills, and handles are pulled to start, lower and stop the drills. These drills descend very near the fingers, and attention is required to avoid an accident."

23. This observation completes the data collected under the direction of the Committee with respect to output by women and girls under the system of discontinuous night work in munition factories. In the aggregate the investigations comprise some hundreds of employees in representative factories, and may justly be regarded as typical of the conditions obtaining to-day. The individual results vary, but their general trend is unmistakable, and the inference seems valid that *in monotonous processes which call for little physical effort, such as those concerned with cartridge making, discontinuous night work of women gives an output which rarely falls much more than* 10 *per cent. below, and usually closely approximates to, that obtained by day.* There is a certain amount of evidence that, in the case of less highly monotonous processes, the inferiority of night output is somewhat greater, but even in that case, percentages much below 90 have not been obtained.

Conclusion 1.

24. Before basing an argument on this finding, it is well to recur to the point made by Dr. Vernon that an equality of output does not prove the harmlessness of night work, since a control experiment, in which the absolute output can be contrasted with that reached by workers on day shifts, who do not work at all by night, is required. Dr. Vernon secured such a control, but as in all the other factories the workers who were only employed by day were of less skill and experience than their fellows, no similar second control was possible. Captain Greenwood, however, endeavoured to provide an indirect control in the following way:—If night work injuriously affects the worker, then, provided all other conditions were the same, the output of the day workers in a factory managed on the *continuous* system (*i.e.*, the night workers never employed by day and conversely) should, on the average, exceed that of the workers in a factory managed on the discontinuous system, where, by hypothesis, all spend a part of their time in the night shift. It is, of course, a task of extreme difficulty to secure the postulated equality of all other conditions; indeed, as Captain Greenwood pointed out, it was impossible to obtain more than an approximation to this. He did, however, find a small number (five) of cartridge processes, carried out by four important firms on identical machines, the firms being of equally high standing. An investigation of the hourly outputs showed that the day workers did not occupy a constantly superior position to the discontinuous workers. The output for each of the five processes was compared, and the place of the day workers in the continuous factory was first, second, third, third and fourth; that is to say, they took an average position between the second and the third, or in other words, their production was not superior to the average of the other factories working the discontinuous system. The value of this indirect control is, for reasons pointed out by Captain Greenwood in his report, definitely less than that of the direct control furnished by Dr. Vernon, but it leads to the same conclusion, and the Committee think that the generally favourable results of the day-night comparisons in factories worked on the discontinuous system are not vitiated by any serious fallacy of the kind suggested above.

25. *Continuous Employment of Women in Night Shifts.*—The continuous employment of women in night shifts is not of common occurrence in munition factories, and the data available for analysis consist of two sets, provided respectively by Dr. Vernon and Captain Greenwood; the

---

* This remark refers to the operations Mr. Florence was discussing, not to all cartridge processes.

great importance of the subject, however, necessitates a somewhat detailed examination. Dr. Vernon's observations will be dealt with first.

Dr. Vernon's chief data refer to 72 cartridge workers, who, after working on the discontinuous system, went on to continuous day work for a period of five weeks, thereafter reverting to the discontinuous system; and to 74, who *vice versa* worked continuously in the night shift for the same period of five weeks, thereafter also reverting to the alternating system. Three of the operations concerned are included in those discussed above; the remainder were "sorting after head trim," "rectifying," and "piercing," all sedentary occupations, and the two latter semi-automatic. For the purposes of analysis the whole period was divided into four intervals—(i) a discontinuous period of six weeks, followed by (ii) a continuous period of four weeks, to which succeeded (iii) and (iv) a discontinuous period of 10 weeks divided into two portions of five weeks each. The hourly rate of output of the workers employed on continuous day shift was 0·9% less than the average output during the preceding and succeeding intervals when alternate weeks were worked. In the case of the continuous night workers, the hourly output was 4·4% less than the average of the same workers when on discontinuous night work before and after the period. The results for the individual operations are irregular, as might be anticipated, in view of the small numbers of individuals of each group, but there is a decrease in every case among the continuous night workers, varying from 8·7% to 1·1%. The continuous day workers showed a diminution in four out of the six operations, the range being from a decline of 2·5% to an increase of 1·1%. On account of the irregularities just noted, the Committee do not feel justified in concluding that continuous day work was *less* advantageous than discontinuous day and night work, though they think it was not appreciably more advantageous.

26. Dr. Vernon's second set of data relate to 12 women employed on continuous night work in "sorting cartridge cases." They were observed through 12 weeks, between 3rd January and 25th March, 1916, after which they changed to the discontinuous system, with weekly change. The mean output for the 12 weeks on continuous night work was 89, while for the subsequent 10 weeks, on discontinuous night work, it rose to 99, an improvement of 11%. Another group of 13 workers, who had been on the discontinuous system throughout, gave means of 106 and 107 for the two periods, an improvement of less than 1%, so that the 11% increase observed would appear to be due to the discontinuous system.

27. Captain Greenwood's report was based upon a study of the output of workers in the "case and bullet department" of a cartridge factory, employing the continuous system. No Sunday work was done. The night shifts were of 7 hours (actual working time) or 42 hours a week, the day shifts were 7½ hours daily, except Saturdays, when the shifts were 7½ hours and 4 hours alternately (the organisation was into three shifts, one night and two day shifts). All the workers were on strict piece work, and the outputs were determined from the piece payments. As to the respective skill of the day and night workers, Captain Greenwood reports thus:—

> "At first an attempt was made to allocate to the night shift the most skilful and reliable workers only. This only partially succeeded, but it is probably true that, particularly in the case of the bullet shops, there is a rather higher proportion of exceptionally skilled workers on the night shift. This original intention was, however, largely defeated by the refusal of various girls whom it was desired to allocate to night work, to accept it. In recent months there has been no difficulty in obtaining volunteers for night work (the piece rate is, of course, higher for night workers), and such selection as has been exercised has been directed to securing the more reliable (not necessarily the more skilful) and, perhaps, socially superior girls, since supervision at night is necessarily less easy to carry out. So far as there is a difference between the workers, the night hands have the advantage, but it should be emphasised that the difference, if any, is not great."

Two sets of observations were made. The first set covers a period of 11 weeks, from the week ending 24th January, 1916 (excluding the week ending 14th February, the records of which were missing), and refers to 84 day workers and 25 night workers in the "case department." Fortnightly observations were made over the same period upon the output of 163 day workers in the "bullet shop" and of 63 night workers.

28. The second set comprises nine weeks' observations of the output of 92 day and 31 night workers in the "case department" and of 96 day and 48 night workers in the "bullet department." This period began with the week ending 1st May, 1916, and the persons observed include many of those dealt with in the first set. The mean rates of production (expressed in an arbitrary unit) were found to be:—

Winter Observations.

Case Department { Day workers, 150 ± 3·2. / Night workers, 125 ± 5·3.

Percentage inferiority of the night workers, 17 ± 4·1.

Bullet Department { Day workers, 157 ± 2·4. / Night workers, 141 ± 3·7.

Percentage inferiority of the night workers, 10 ± 2·8.

Summer Observations.

Case Department { Day workers, 170 ± 3·2. / Night workers, 149 ± 3·9.

Percentage inferiority of the night workers, 12 ± 3·0.

Bullet Department { Day workers, 169 ± 3·2. / Night workers, 170 ± 3·5.

Percentage inferiority of the night workers, 0 ± 2·8.

In both series of observations the night workers of the " case department " compare very unfavourably with the day workers. The same remark applies to the " bullet workers " during the winter period, but in the records of the summer months the two groups are practically equal. As the actual means in the second series are all higher than in the first, it might be thought that the partial approximation was due to the effects of practice, and that the night workers had had less experience at the commencement of the observations. Dr. Vernon has shown in connection with some data, which will be examined in the section devoted to the labour of men, that an apparent inferiority of night shifts is much reduced by allowing for experience. This is not, however, the explanation of the present results. Between the two periods of observation the piece rates were altered, and although allowance has been made for this fact, the second series of means having been multiplied by the ratio of the mean rates obtaining in the two periods, it may well have had some effect upon output. Further, the successive weekly means do not show signs of regular improvement in either series; in one particular case they show the reverse.

Captain Greenwood also analysed these data from the point of view of ascertaining whether the continuous night workers progressively deteriorated in comparison with the day workers. He found in one series signs of such progressive deterioration, but as his other series did not effectively confirm this result, he was of opinion that the data did not warrant the formulation of any definite conclusion upon the point. Since the details of this investigation are necessarily somewhat technical, and the Committee endorse Captain Greenwood's judgment as to their outcome, it has not been thought desirable to reproduce the calculations in this memorandum.

29. The day and night workers also contrast unfavourably in another respect. The general question of lost time in day and night shifts will be considered in a later section, but, as Captain Greenwood's series is the only one based upon comparatively large numbers of women employed upon the continuous night-shift system, it is convenient to note certain of his results in this place. The analysis in the case of the winter samples rested upon 25 night and 84 day workers in the case department, but the numbers with which he started were respectively 37 and 100. Of these original totals 12 and 16 ceased to be employed within the period of observation; that is to say, 32·4% of the night workers, as compared with 16% of the day workers. This great discrepancy was not observed in all the samples, but when a complete summary of the possible and actual weeks worked by both classes was made, it appeared that the day workers missed 209 out of a possible total of 3,715 weeks and the night workers 133 out of a possible total of 1,529, percentages of 5·63 and 8·70. These figures do not refer to lost time as a whole, but merely to complete weeks lost. They indicate that the regularity of employment is decidedly inferior in the case of the night workers.

30. The Committee think that the outcome of Dr. Vernon's and Captain Greenwood's* investigations makes it highly probable *that continuous night work is productive of definitely less output than is the discontinuous system; and the Committee have failed to obtain evidence that the output of the continuous day shift balances this inferiority.*

Conclusion 2.

II.—Lost Time.

31. The Committee are devoting a separate study to the question of lost time, and only such observations as are directly relevant to the comparison of day and night efficiency are considered here; and only passing references are made to the items of which lost time is composed, *e.g.*, lost days, lost hours and lost weeks, and to the reasons for such lost periods, *e.g.*, sickness and avoidable causes.

Information referring to women employed, during March, 1916, on three eight-hour shifts, was obtained by Professor Loveday, who found that for a sample of 2,603 working on the day shifts 10·4% of time was lost, and for a sample of 1,175 working on the night shifts 13·2%. The amount marked as unavoidable was, however, rather more by day than by night—a difference which is still greater in the case of men, *vide infra*; Professor Loveday suggests this may be due to selection, employees who appeared to be unwell being excluded from the night shift; while the greater amount of time lost on night shifts due to other and avoidable causes may be explained on the lines of the passage quoted in paragraph 2.

Further information concerning women and girls employed on eight-hour shifts was obtained by Mr. Florence. It refers to a period of three months, and shows that the gross percentage losses were 5·77, 5·30 and 6·90 for the day shifts, and 4·15, 9·16 and 8·40 for the night shifts.

These observations suggest that there is, on the whole, a somewhat greater loss of time in night shifts, and this fact renders the comparison on a basis of the hourly output of individuals somewhat too favourable to the night workers. The difference is not, however, absolutely great or constant.

32. *Discontinuous and Continuous Systems.*—Information in respect of 701 women and girls engaged in the sedentary occupations of " viewing," gauging and assembling the component parts of fuzes, was obtained by Dr. Vernon over a period extending from 14th February, 1916, to 23rd July, 1916. The hours of work of the day shift were normally 66·5 per week, except in the second week of each month, when they were reduced to 58·5 hours owing to the remission of Sunday labour. The hours of the night shift varied from 62·5 to 56·5 per week.

---

* Captain Greenwood has pointed out that the inferiority is, in his data, more evident in the case of winter observations, and he notes that one of his discontinuous series (also derived from winter observations) gave an output which, although superior to that of the continuous workers was lower than any other value in his (or Dr. Vernon's) series.

TABLE III.

System of work.	Statistical period.	Girls aged 19 or 20.				Women aged 21 and over.			
		Mean percentage of time lost.				Mean percentage of time lost.			
		Due to—			Total.	Due to—			Total.
		Broken time.	Short weeks.	Absent weeks.		Broken time.	Short weeks.	Absent weeks.	
Permanent day ...	14th February to 30th April.	5·0	3·0	4·3	12·3	4·4	2·8	3·4	10·6
	1st May to 23rd July	4·1	1·4	3·3	8·8	4·1	1·9	1·2	7·2
Discontinuous weekly.	14th February to 30th April.	4·2	2·7	1·8	8·7	3·3	2·2	1·8	7·3
Discontinuous fortnightly.	1st May to 23rd July	4·6	2·1	0·9	7·6	4·1	1·9	1·0	7·0

One group of these workers was employed during the first 11 weeks on day and night shifts in alternate weeks, and during the following twelve weeks on day and night shifts in alternate fortnights; the remainder of the workers were employed on permanent day shift throughout the whole 23 weeks, and their lost time is a valuable check upon that experienced by the groups working on the discontinuous systems. The results obtained, which are summarised in Table III, indicate, as might have been anticipated, an improvement with the advent of summer, an improvement which for the permanent day workers is shown under each sub-division of lost time, but which for the discontinuous workers is not present when " broken time " only is considered. Dr. Vernon looks upon this latter point as in itself showing that fortnightly alternation produces worse timekeeping than weekly alternation, for he considers that " broken time " probably includes a greater proportion of time lost through unpunctuality and slackness than do " short weeks " and " absent weeks," which are more likely to be due to genuine indisposition and sickness. He concludes that:—

> " The alternate-week system of shifts is certainly better for timekeeping than the alternate-fortnight system, for in the spring period, when alternate weeks were worked, the timekeeping was relatively much better than that of the permanent day shift, whilst in the summer period, when alternate fortnights were worked, it was almost the same as that of the permanent day shift."

TABLE IV.

Four-weekly period from	221 women, aged 21 and upwards.				89 girls, aged 19 or 20.			
	Night shift.		Day shift.		Night shift.		Day shift	
	1st week.	2nd week.	1st week.	2nd week.	1st week.	2nd week.	1st week.	2nd week.
1st May to 28th May	5·8	6·5	5·4	8·0	4·7	8·0	7·8	6·6
29th May to 25th June ...	6·7	7·3	8·6	6·7	6·8	6·9	7·0	6·0
26th June to 23rd July ...	4·8	5·3	10·6	7·8	7·5	8·9	11·7	9·3
Mean lost time	5·8	6·4	8·2	7·5	6·3	7.9	8·8	7·3

He also obtained further evidence (Table IV) of the disadvantages of the alternate-fortnight system by grouping the data according as they relate to the first and second weeks of the day-shift and night-shift fortnights, when he found that:—

> " On an average the lost time of both women and girls was distinctly greater in the second week of each night-shift fortnight than in the first week, whilst it was distinctly greater in the *first* week of each day-shift fortnight than in the second week, or it corresponded with the hourly output variations of fuze-turning women described in a previous section. It would appear, therefore, that night work had a cumulatively harmful effect on timekeeping just as it had on output, and that this harmful effect extended to the first week of the day-shift fortnight."

33. The absolute amount of lost time, however, during the night-shift fortnight was less than that during the day-shift fortnight, and the same thing held good for the night shift as compared with the day shift on the weekly alternation. The explanation suggested by Dr. Vernon is, first, that workers by night are not subject to the same opportunity of oversleeping themselves as the day workers are; and, secondly, that the effects of night work do not appear for some days, and hence are mainly exhibited in the subsequent period of day work.

TABLE V.

Age of Workers.	Permanent day shift.								
	11 weeks from 14th February to 30th April.					12 weeks from 1st May to 23rd July.			
	Average No. of workers.	Percentage of time lost as				Average No. of workers.	Percentage of time lost as		
		Broken time.	Short weeks.	Absent weeks.	Total.		Broken time.	Short weeks.	Absent weeks.	Total.
21 and over	126	4·4	2·8	3·4	10·6	96	4·1	1·9	1·2	7·2
19–20 ...	59	5·0	3·0	4·3	12·3	43	4·1	1·4	3·3	8·8
17–18 ...	41	4·4	2·2	2·6	9·2	33	4·3	0·6	0·3	5·2
14–16 ...	66	3·9	2·3	1·9	8·1	63	3·1	0·9	2·8	6·8
	292	4·4	2·6	3·1	10·1	235	3·9	1·2	1·9	7·0
	Alternate weeks of day and night shift.					Alternate fortnights of day and night shift.				
21 and over	133	3·3	2·2	1·8	7·3	221	4·1	1·9	1·0	7·0
19–20 ...	52	4·2	2·7	1·8	8·7	89	4·6	2·1	0·9	7·6
17–18 ...	19	3·1	2·9	3·3	9·3	30	4·2	1·4	1·7	7·3
15–16 ...	13	3·6	0·7	4·6	8·9	22	3·5	1·0	0·4	4·9
	217	3·5	2·1	2·9	8·5	362	4·1	1·6	1·0	6·7

In addition to the data summarised above for women and girls of 19 years of age and upwards, Dr. Vernon also investigated the lost timekeeping of younger girls; and found that:—

> "Girls of 14-16 were the best timekeepers, whilst those of 19-20 were the worst. This result corresponds with the data recorded in Memorandum 12, which relate to 400 of these women and girls for a period reaching from 8th November, 1915, to 12th March, 1916. On an average the young girls kept better time than the rest, whether they were on permanent day shift or on day and night shift, but the influence of age is in no case very marked. Taking an average of the four values obtained for each age group, we find that the total lost time of girls aged 14-16 was 7·2%; of those aged 17-18, 7·7%; of those aged 19-20, 9·3%; whilst for women of 21 and upwards it was 8·0%. The girls of 15-18 did not take to night work so well as the girls and women of 19 and upwards, for their average lost time was 0·3% greater than that of girls of the same age on permanent day shift, whilst the average lost time of the older girls and the women on day and night shifts was 2·0% less than that of the corresponding permanent day shift."

Reviewing the data, the following conclusions may be suggested:—

Conclusion 3.

(*a*) *The timekeeping of girls and women of* 19 *years of age and upwards, working for alternate weeks of day and night shift, is even better maintained than when they work on permanent day shift.*

(*b*) *The timekeeping of girls of* 14-18 *is practically the same, whether they work on permanent day shift or on day and night shift.*

MALE LABOUR.

I.—Output.

34. *Discontinuous Employment of Men in Night Shifts.*—The statistical data relating to the employment of men collected for the Committee are necessarily smaller in extent than those upon which the conclusions regarding the employment of women is based. The reason is that for the purpose of an exact measure of output it is usually requisite to study manufacturing processes of a repetitive character in which a fairly comparable unit of production is usual. This condition seldom applies to processes which are of a highly skilled character, or call for the expenditure of considerable physical force, and so comparatively few operations employing only men could be studied. All the data used refer to the manufacture of shells, and have been contributed by Dr. Vernon, Captain Greenwood and Mr. Burchell. Apart from forging, the number of operations involved in the manufacture of a shell is between

20 and 30, and a few notes on the character of these operations will enable the reader to contrast them with the type of process dealt with in the case of women. The operations which have yielded the most individual records are those of "boring the powder chamber," "turning," "finishing," "shaping," "copying" and "base and nose screwing." These operations essentially fall into two groups, that of boring, in which a conical chamber at the base of the shell is excavated to hold the explosive charge, and the other operations in which various lathe tools shape different parts of the steel cylinder and adjust its dimensions. Dr. Vernon's succinct remarks on some typical operations may conveniently be quoted. Of boring, he writes:—

> "This consists in boring out a shallow conical chamber at the base of the shell to hold the explosive charge, and in forming a shoulder above it upon which rests the diaphragm separating the powder from the shrapnel bullets above. The boring tools are fixed on three arms of the capstan, which can be automatically driven forward into the shell by the lathe gearing. As a rule, the operator preferred to drive it forward by a hand lever, as he could thereby bore considerably faster, but it meant that he was doing a considerable amount of work during the whole of the operation. After the powder chamber has been bored the shell is faced, rendered conical by hydraulic pressure, and tapped, and is then submitted to the operation known as 'finish, turn and form.' A fine turning is taken off the shell, and as this is for the most part an automatic process the operative meanwhile files down a previously turned shell to its exact diameter."

Most of the other operations are more automatic:—

> "In the operation of rough turning, the rough steel shell, after it has been cut down to the right length by the operation of 'parting off,' is turned approximately to size. This takes about five minutes, during four of which the operative merely watches the lathe. In that the outer skin of steel becomes hardened in the forging, this rough turning requires more powerful lathes and tools than other operations, and there is often some delay from the replacement of a broken or blunted tool. In the operation of 'parting off' the operator is performing active mechanical work, either in clamping the shell in the lathe or in adjusting the cutting tool, for about a third of the time taken by the operation, and slight mechanical work during the remainder of the time. This operation does not require much skill. In the operation of 'finishing rough turning' the roughly turned shell is fixed to a lighter type of lathe, and has a second turning taken off it, but this time a very thin one. This operation takes less than two minutes, and during six-sevenths of the time the operator stands watching his lathe."

35. Dr. Vernon's notes refer to the manufacture of 3-inch shrapnel shells, while Captain Greenwood's and Mr. Burchell's data are concerned with 6-inch and 9·2-inch shells. The general characters of the operations are, however, similar, and the impression created by Dr. Vernon's notes, that in comparison with the cartridge processes a somewhat greater degree of muscular energy and a more intermittent activity (*e.g.*, the waiting of the operative while the tool pares away a skin of metal) are involved, is equally true of the heavy shell processes. The question of muscular activity deserves rather more emphasis, of course, in the case of heavy shells than in that of 3-inch shells. At each lathe operation a massive steel cylinder has to be lifted and brought to the working face of the lathe. The degree of exertion imposed on the operative depends on the perfection of the hoisting tackle. In one of the factories visited by Captain Greenwood and Mr. Burchell the individual effort was greater than in another where the hoisting machinery was of a more elaborate pattern, with the result that in the latter shop operations, entrusted to men in the former factory, were carried out by women.

36. The data provided consist of three series from Captain Greenwood and Mr. Burchell and one series from Dr. Vernon. The three former series relate to discontinuous night work, two with weekly changes, and one with a monthly change. Dr. Vernon's data come from a factory organised on the continuous system; they will be studied in a separate section.

37. Captain Greenwood and Mr. Burchell's best series consist of a study of 138 men engaged upon 6-inch shells, and followed through a series of 12 weeks from the week ending 10th January, 1916. The number of hours worked and the output were recorded for each individual. The men worked for four weeks in the day shift, and then for four weeks in the night shift, or conversely. The average weekly hours worked were 54 hours in day shifts and 57 in night shifts. The investigators state:—

> "Although we had been told that most of the men were old hands, we did not know that they had always been employed upon the same operation, and before determining the night and day ratios in the way explained by one of us in earlier reports, it was necessary to be sure that no fallacy of comparison due to increasing experience vitiated the results. In effect we found that an allowance had to be made. Thus, we could compare for each operation the outputs of the same workers after the lapse of two months by taking the relative production of successive night shifts or of successive day shifts. The result was that in all 15 operations tabulated only one showed a decline, and the weighted average improvement was found to be 6·9% for the night-night comparison, 6·0% for the day-day comparison, or an average weekly improvement of about 0·8%. Consequently a simple comparison of the summed outputs would be misleading, for in some part of the data the night-shift month preceded the day-shift month, and in others it followed it. As the numbers in the two groups were nearly equal, the error so introduced would be small, but it has been eliminated by calculating the individual ratios in the following way. A man belonging to the night-day-night series had his mean production for the months on night work divided by the mean production of the month on day work. A man belonging to the series day-night-day had his night-month mean divided by the mean of the two day-months. The means of each of the two series did not differ appreciably

one from another nor from the mean of the whole 138 ratios. The general mean was 103·8, with a ' probable error ' of ± 0·40. That is to say, the night labour was slightly more productive than the day labour, significantly so, in the sense that the difference was not likely to be an error of sampling, but evidently it is of slight practical importance."

38. The investigators also determined whether the change from work in one shift to that in another was associated with a relative fall in output. They found that the night-to-day ratio, when the first week of the night shift was compared with the last week of a day shift, did not differ appreciably from the general average. They also compared the average outputs for successive weeks of night work in several operations and found no uniform changes. Thus in the operation of " nose screwing " the successive weekly averages were 1·189, 1·223, 1·244 and 1·308; in the operation of " copying," 1·285, 1·289, 1·328 and 1·311; and in the operation of " base screwing," 1·348, 1·342, 1·527 and 1·438. The conclusion to be drawn appeared to be that no deleterious effects of night work upon output could be demonstrated, and that on the whole the night shifts were slightly the more productive.

39. Limitation of output was alleged to be taking place at this factory, and the question was investigated in the following way. The variability of output of men working precisely the same number of hours should be slight if serious limitation of output exists. The percentage variabilities of men working exactly 60 hours in the case of " nose screwing " and that of " base screwing " were found to be 17·01 ± 1·2 and 8·8 ± 0·6, the similar percentages of men working just 66 hours were 20·5 ± 1·4 and 8·1 ± 0·6. The weighted average for the four sets was 13·9. This variability was rather greater than that found in girls employed on three operations in a cartridge factory, viz., 7·3%. The investigators write:—

" The latter (*i.e.*, the cartridge workers) no doubt approach the lower limit of variation in industrial output, since the pace is much more closely set by the machine than it is in shell production, where a considerable fraction of the working time is necessarily occupied in lifting and adjusting the heavy metal cylinders submitted to the various lathe operations. The greater variability is therefore what we should anticipate, and the result is not a conclusive proof that *no* limitation of the natural variation has been produced. It is, however, evident that output had not been reduced to a dead level."

40. Captain Greenwood's and Mr. Burchell's next series comes from the factory providing the three-shift data quoted in paragraph 19. The men worked in two shifts, a day shift of 9½ hours and a night shift of 11½ hours. No night work is done on Saturdays. Shifts change weekly. Four operations were investigated from the week ending 1st July, 1916, to the week ending 7th October, 1916 (inclusive). The hourly output of the night shift, expressed as a percentage of the day-shift hourly output, was found to be 100·9 in " profiling," 102·5 in an operation called " drawback necks," 95·1 for " boring " and " facing noses," and 104·3 for " grinding." The numbers of employees are approximately known in the case of three out of four of the processes, viz., 28 for " profiling," 4 for " boring " and " facing noses," and 17 for " drawback necks." These statistics are of inferior value to the previous series, but agree in the general result, viz., no sustained inferiority of night work.

41. The last series is a set of observations upon the hourly output of the forging squad in a shell factory. The average strength of the squad was nine in the day and nine in the night shift, and they changed weekly. The weekly hours were 53 for each shift. Two sets of observations were available relating to the same men. The first covers a period of five weeks from 3rd September, during which period the men were on time work. The second covers four weeks, and the men were then on piece work. During the former period the percentage ratio of hourly production by night to hourly production by day was 95·5. For the second period it rose to 109·3. The apparent rise in relative efficiency of the night shift, when the time payment was replaced by piece payment, was thought by the firm to be due to the fact that supervision is necessarily less close in the night shift, so that the incentive of piece remuneration is required to call forth the maximum efforts of the men. The series is, however, a short one, and the variations from week to week are considerable, so that no great stress can be put upon the result.

42. These three series of data, particularly the first, which is the most detailed, create an impression similar to that produced by the more extensive data of female employees, namely, that *there is no significant difference between the rate of output in night and day shifts managed on the discontinuous system.* If there be any difference, it would seem that the output is slightly better by night for the particular class of work involved.

Conclusion 4

43. *Continuous Employment of Men in Night Shifts.*—Dr. Vernon's data consisted, as mentioned above, of records derived from a factory producing 3-inch shrapnel shells. The day shifts usually worked 53 hours a week, exceptionally 64 hours. The night shift worked either 47½ hours or 57½ hours, sometimes 67 hours. In the operation of " boring the powder chamber " the output was investigated during 14 consecutive weeks from 30th August, 1915, the numbers involved being 23 in the day and 17 in the night shift:—

" In the first four weeks, viz., from 30th August to 26th September, the average hourly output of 17 men on night shift was 25% less than that of 23 men on day shift. This great defect was largely due to the fact that the night shift was newer to the work and had been on the operation only three weeks previous to the statistical period, while the day shift had been 10 weeks on an average. The men appear to take about three months to work up to their maximum output. The data show that the output is fairly steady after the day shift had had 19 weeks' experience, and the night shift 12 weeks' experience.

Week ending	23 men on day shift.			17 men on night shift.			Percentage of night shift output on day shift output.
	Relative hourly output.	Actual hours of work per week.	Percentage of broken time per week.	Relative hourly output.	Actual hours of work per week.	Percentage of broken time per week.	
7th November	108·0	48·5	2·0	95·0	46·3	2·5	88·0
14th „	108·0	47·0	5·1	89·0	46·6	1·9	82·0
21st „	115·0	59·5	7·0	93·0	46·8	1·5	81·0
28th „	106·0	60·5	5·5	94·0	66·9	0·2	89·0
5th December...	101·0	59·1	2·3	92·0	64·6	3·6	91·0
Mean	107·6	54·9	4·4	92·6	54·2	1·9	86·2

" These data show that the average output of the night shift was 13·8% less than that of the day shift over a five-week interval. During the last fortnight it was only 10% less, but in any case the inferiority of output was considerable. In another group of men who were using a different type of lathe to bore the powder chamber, the average hourly output of 18 men on day shift was 100, 106 and 105 respectively in the three weeks ending 5th, 12th and 19th September, whilst the average hourly output of 20 men on night shift was 96, 94 and 99 for the same weeks. On an average the night-shift output was 7% less than that of the day shift, but in that the night shift had had only seven weeks' experience at the operation previous to the statistical period dealt with, whilst the day shift had had 10 weeks', it is probable that the difference of output would ultimately have become less than this figure. We may sum up by saying that the average output of both groups of night workers was probably 9% or 10% less than that of the day shift."

44. In the operation of " finishing, turning and forming " 22 men on day shift were compared with 17 on night shift for seven weeks. In this case the comparison was also complicated by differences in length of employment and by the fact that, prior to the period investigated, the hours worked were 12 to 15 hours longer per week than during the period itself. Dr. Vernon concluded that the difference shown during the last two weeks, viz., 1·5%, was more nearly a measure of the real difference than the average over the whole period, viz., 7·9%. In the operation of " rough turning," a comparison of 18 men on day shift with 20 men on night shift showed the hourly output of the night workers during the last five weeks of the statistical period to be 6% less than that of the day workers. Dr. Vernon further states:—

" If the deficit in the output of the night shift on that of the day shift in the ' powder chamber boring ' operation be taken as 10% and in the ' finish, turn and form ' operation as 2%, the mean deficit comes to 6%, or the same as for ' rough turning.' In two other smaller groups of operatives the mean deficit likewise amounted to 6%, though probably by reason of the smaller numbers involved, the differences of day- and night-shift output in the two operations was considerable. Thus, in the operation of ' finish rough turning,' or taking a thin turning off the roughly turned shell, the output of nine night-shift workmen was 14% less than that of nine day-shift workmen over a period of four weeks. In the operation of ' parting off,' or cutting down the rough shell to the right length, the output of seven workmen on night shift was 2% *greater* than that of seven on day shift over a period of three weeks."

45. If now the general results of the investigations of Captain Greenwood and Mr. Burchell on the one hand and of Dr. Vernon on the other be contrasted, it seems that *with men, as well as with women, the discontinuous system is preferable to continuous night work.* Conclusion 5.

II.—Lost Time.

46. Consideration of time lost by night must always be weighted by the fact that at night the rate of remuneration is higher, and therefore that there is a greater incentive for workers not to lose time as compared with workers by day.

Discontinuous System.—Professor Loveday has provided data relating to some 5,500 skilled workers employed by day, who lost 11% of time " avoidably " and 5·5% unavoidably; that is to say, 16·5% in all; and of 2,700 skilled workers employed by night who lost 6·3% of time avoidably and 2·1% unavoidably, that is to say, 8·4% in all; and also of over 8,600 unskilled workers employed by day who lost 10% avoidably and 5·2% unavoidably, that is to say, 15·2% in all; and, lastly, of 4,376 unskilled workers employed by night, who lost 8·1% and 2·2% respectively, 10·3% in all.

These data definitely suggest that men employed on the discontinuous system lose less time at night. All comparison, however, of the time lost by day with that lost by night must make allowance for one important probable cause of bad timekeeping in the day period, namely, time lost before breakfast in the morning, which accounts generally for a very high proportion of the total amount of time lost during day work. This matter is examined in a separate study, but it takes away any value the percentages might be thought to have as evidence of the inherent advantage in night shifts.

47. *Continuous System.*—Dr. Vernon has provided data which refer to 83 permanent day-shift workers and 50 permanent night-shift workers for an average period of eight weeks lying between the 25th July and the 5th December, 1915. He found that the total lost time of the night workers was

5%, and that of the day workers 4·4%, or 0·6% less, a difference which was due to the smaller number of short weeks put in by the day workers. He considered the data sufficient to be some indication that the health of the permanent night-shift male workers is not quite so good as that of the permanent day-shift workers, but does not consider the difference one of much practical importance. Captain Greenwood investigated the timekeeping in another factory employing a permanent night shift through 47 weeks, between June, 1915, and September, 1916. During this period, out of 409,727 possible day shifts 16,418 were lost, a percentage of 4·0. Out of 132,334 night shifts 7,593 were lost, a percentage of 5·7. In both shifts there was a substantial improvement in shift-keeping (the data refer to absolute losses of shifts, not to broken time) in the summer; but over the whole period the night shift-keeping was nearly 43% worse than the day shift-keeping. Captain Greenwood pointed out that the relative losses were similar to those found in the cartridge factory managed on the continuous system. This observation confirms that of Dr. Vernon, *and strengthens the case against permanent night work for men.*

GENERAL CONCLUSIONS.

48. The investigations were not primarily aimed at comparing the output of day work with that of night work, as the case against night work was considered to be sufficiently established; some of the data, however, permit a comparison to be made, and in each case the comparison is to the detriment of night work. Night work, though necessary in the present crisis, is, then, undesirable; but the Committee consider that the extensive and varied data which have been summarised above provides material upon which certain conclusions, having reference to relatively light repetition work, may be based as to the result upon output to be anticipated from different schemes of night work.

49. *Women.*—(1) In monotonous processes which call for little physical effort, such as those concerned with cartridge-making, discontinuous night work of women gives an output which rarely falls much more than 10% below, and usually approximates closely to that obtained by day.

(2) Continuous night work is productive of definitely less output than is the discontinuous system; and the Committee have failed to obtain evidence that the output of the continuous day shift balances this inferiority.

(3) (*a*) The timekeeping of girls and of women of 19 years of age and upwards, working for alternate weeks of day and night shifts, is even better maintained than when they work on permanent day shifts.

(*b*) Timekeeping of girls of 14 to 18 is practically the same whether they work on permanent day shifts or on day and night shifts.

The Committee, basing their opinion upon these conclusions, consider it *undesirable to adopt for women continuous night shifts in any factory not at present so working or not yet open, and suggest that wherever practicable this system should be discontinued.*

50. The Committee believe that this inferiority of the continuous night worker may ultimately be referred to a failure to secure proper rest and sleep in the day time. Women on continuous night work are likely to perform domestic duties which, when they work alternately in the two shifts, is impracticable; and this extra domestic strain may account for the inferior results of their industrial activities. The Committee has, indeed, some evidence of women employed in permanent night shifts who still carry on their ordinary day-time avocations, but it is not sufficiently extensive (statistically) to be offered as a proof of the suggestion just made.

51. *Men.*—The conclusions arrived at with respect to women are true, with slight modifications, for men.

(1) There is no significant difference between the rate of output in night and day shifts managed on the discontinuous system.

(2) With men, as well as with women, the discontinuous system is preferable to continuous night work.

There is no reason to think that the nightly output need be much, if at all, inferior to the output by day in the case of a discontinuous system, and there is evidence that the timekeeping by night is rather better than by day. The contrast between permanent night shifts and permanent day shifts is, however, less striking than in the case of women. On the whole, it appears that the rate of output may be less and the loss of time greater than in the discontinuous system. This result is what might be expected, if the surmise regarding the cause of the inferiority seen among women were correct. Men do not naturally take so much part in domestic work as women, and the temptation to burn the candle at both ends is, from this point of view, smaller. On the other hand, the incitement to devote the time which should be given to sleep to amusement is certainly as intense among men as among women, so that some inferiority might be anticipated.

The practical conclusion seems to be, therefore, that, equally with women, *men can more profitably be organised under the discontinuous than under the continuous system of night work.*

THE CAUSES AND CONDITIONS OF LOST TIME.

BY

T. LOVEDAY, M.A.

CONTENTS.

I.—INTRODUCTION.

(a) *General Remarks.*

1. The following notes are based in the main on an inspection of the records of lost time in a number of factories situated in different parts of Scotland and England. Occasionally I have made use of figures from factories which I have not visited, when I knew the figures to be well authenticated. I have also had the benefit of the opinions of a number of directors, managers and other officials, as well as of employees, to all of whom I am greatly indebted.* In all matters affecting lost time the variables are so numerous as between different factories, and even as between different departments in a single factory, that more weight ought properly to be attached to coincidence or divergence of opinions among experienced persons than to coincidence or divergence of figures: unfortunately, the former are less easily reproduced on paper and are apt to lose force in telling. But much of what follows is based on an estimation of experienced opinions. I am very sensible of, and wish to emphasize at the outset, the danger of easy generalisations about lost time. Much that has been written on the subject is marred by a failure to recognize the large element of conjecture necessarily present in any general conclusions on the subject. At the same time it is likely that a comparison of results under varying conditions may convey to persons interested some useful information.

* I have also to express my great obligation to Mr. H. O. Quin, of the Ministry of Munitions.

2. The present communication does not pretend to treat exhaustively the whole problem of lost time in factories. The chief causes of loss of time operative at present may be summarised as follows:—

A. Causes mainly Uncontrollable.

(1) Necessity of employing persons of inferior physique or irregular habits.
(2) Lack of housing accommodation.
(3) Lack of transport facilities.
(4) Bad weather and dark streets.
(5) Lack of material coming from outside.
(6) Domestic duties of married women.
(7) Sickness and accident.

B. Causes mainly Controllable.

(1) Drink.
(2) Indifference.
(3) Discontent with conditions of work.
(4) Morning "quarters."
(5) Overtime work.
(6) Faulty internal organisation, leaving employees without work.

Other causes, of less importance, might be added, and even those mentioned differ considerably both in influence and in generality. The first seven of them are for the most part beyond the control of either employer or employee: the remainder might to a great extent be remedied by the one or the other. The discussion that follows is mainly concerned with the proportions of lost time that are due to *sickness* and to "*sleeping in*" or *loss of morning "quarters"*; but in both connections some discussion of the influence of overtime is unavoidable.

3. I have in the main confined myself to the records of factories which existed before the war, are still largely engaged upon work not very remotely different from that on which they are normally engaged, are admittedly well managed, and in which the relations between employers and employed are tolerably harmonious. My attempt has been not to lay undue stress on extreme, uncharacteristic figures, but rather to compare average results in well-managed concerns. So far as conclusions are drawn or suggested at all, they appear to me to have a bearing upon problems that will arise after the war as well as upon immediate practical questions, and this is most emphatically true concerning the necessity of improving the form and raising the value of medical certificates.

4. The kind of work on which a factory is engaged is distinguished as Light, Medium, Heavy, and so on. This classification, though accurate in respect of particular shops, is somewhat arbitrary in respect of whole factories, since even in marine engineering and other heavy works a considerable proportion of the labour is light: these terms, therefore, must be taken as characterising only the main features of a factory. All the factories recorded may be brought under the general title of engineering (used broadly) with the exceptions of two cotton factories and one in which women were engaged upon rope-making. All but the cotton factories are "controlled." Shipbuilding is excluded from consideration, except in one table introduced for comparison.

5. Correct and ample records of timekeeping and sickness are rare. In small factories they are often considered unnecessary; a mental note or a few jottings in the works manager's pocket-book are often all that is available. This is unfortunate, for the ease of supervision in carefully managed small factories makes their records specially valuable. Factories which are well satisfied with their employees' timekeeping often hold that continuous records are not worth while—again a scientific misfortune, since comparison with other factories becomes impossible. In large factories, on the other hand, stress of work and depletion of staff have often made it necessary to abandon records which were once carefully kept. Fortunately, however, in a few cases I have found records either instituted or enlarged during the past two years, and they have been of great utility.

(b) *The Form of Time-Analysis Records.*

6. The lost time records of different firms vary greatly in form. A very convenient form for purposes of calculation is a weekly record tabulated as follows:—

Week ending

Shop or Department.	Number employed.	Number of Normal Hours actually worked.		Number of Hours worked Overtime.		Number of Hours Lost.		
		Dayshift.	Night-shift.	Weekdays.	Sundays	Avoidably.	By Sickness.	By Leave.

The individual figures in each department can be read off the employees' cards with great rapidity by clerks accustomed to the work and entered on lists, which may then usefully be preserved with the summary table.

The summary may be expanded as desired by adding columns for such further information as "added time," the number of employees on overtime, the number of "quarters" lost, the number of employees sick, the number of bad timekeepers, and time lost on dayshift as distinguished from nightshift; while some of the columns (or, preferably, percentages calculated from them) may usefully be recorded from week to week in graphic curves.

(c) *Calculations of Lost Time and of Overtime.*

7. Subsequent calculations may be made in averages of hours per employee or in percentages; for some comparisons both methods are needed.

Time lost either with leave given or for sickness or for other adequate reasons is considered as time lost unavoidably; and time lost which is not accounted for in these ways is spoken of as time lost avoidably, *i.e.*, by "bad timekeeping." In making calculations, if percentages be used, the strictest measure of time lost avoidably, *i.e.*, by "bad time-keeping" is $\frac{\text{hours lost avoidably} \times 100}{\text{gross normal hours less those unavoidably lost}}$, but in comparing time lost due to bad time-keeping with that due to sickness, the data for these two causes respectively must be expressed as percentages of gross normal hours less those lost by leave; while time lost for all causes must be expressed as a percentage of gross normal hours simply.

In the following pages the stricter measures are sometimes used, but it will be seen that as a rule the percentages are not greatly altered by taking gross instead of "practically possible hours"* as the denominator throughout.

8. It is sometimes argued that calculations based on the amount of normal time lost are misleading and should be replaced by calculations based on the average number of hours worked, whether normal or overtime. An example will make this argument clear—Suppose a factory in which the average normal hours a week are 55 and the average hours worked overtime are 10, and that the average hours lost are 5 per man, or about 9 per cent. of the normal hours. This percentage cannot be fairly compared with that of another factory whose average normal hours are 50, with no overtime, and where the average hours lost are $2\frac{1}{2}$ per man, *i.e.*, 5 per cent. of normal hours; for, in fact, the men in the former factory are working 60 hours a week, and those in the latter only $47\frac{1}{2}$.

9. This argument is so far sound, that comparisons of the lost time percentages of different firms are of little value unless accompanied by comparisons of the average hours worked. But it neglects two important points:—

(1) Absences of workmen, especially when unexpected, entail a certain amount of disorganisation, and therefore (quite apart from questions of fatigue) the comparative effective value of the longer hours with a high percentage of lost time is diminished; and

(2) So far as work overtime *causes* loss of normal time, the results are greater cost and (usually, at any rate) lower efficiency.

10. To find a satisfactory measure of overtime for purposes of comparison between different factories is difficult. The ratio of hours worked overtime to ordinary hours actually worked is totally useless. The ratio of hours worked overtime to gross possible normal hours is a very rough measure, since there may be much unavoidable absence in one factory and little in another. The total number of hours worked overtime divided by the total number of employees is also a very rough measure for the same reason, and because the proportions of employees working overtime may differ greatly. The simplest and best measure, when the information can be obtained, is (*a*) the percentage of employees working overtime together with the average hours worked overtime by each employee so working, and it may be combined with (*b*) the ratio of hours worked overtime to practically possible ordinary hours, allowance being made for unavoidable absence. But in using these measures consideration must be given to the length of the normal working week if the comparison is not to be very misleading, and in using (*b*) reference should be made, under the two-shift system, to the size of the nightshift if the night-week is longer than the day-week, for in a factory working little or no nightshift the ratio will be higher than when the nightshift is large, though the hours actually worked overtime are the same.

(d) *The Relations between Lost Time and Overtime.*

11. If the term "overtime" be taken in the ordinary sense of hours worked beyond the normal time of a factory, any attempt to correlate lost time and overtime is apt to be misleading, since the normal hours of different factories vary. Nor is the attempt much more hopeful if some such figure as 53 hours be arbitrarily selected as a normal working week and any excess reckoned as overtime; for length of hours is only one of many conditions of lost time, and it would be difficult to find two factories varying in that condition alone. Yet

* The term "practically possible hours" will be used throughout to mean gross possible normal hours less those lost unavoidably.

overtime admittedly does cause loss of normal time. The point will be frequently illustrated later on in this memorandum, but a few general observations may be in place here.

Overtime may act either as final or as efficient cause of lost time.

(1) Employees may deliberately miss normal hours in order to make the better-paid hours overtime necessary. In no factory that I have visited has the management believed this practice to be followed by any but an insignificant minority of the employees. If it be anywhere at all common, an extension of the rule found in many places would seem desirable, by which the full normal week must be worked before overtime is paid as such—always provided that normal time is not excessive and that allowance is made for sickness and other unavoidable absence.

(2) Work overtime may have loss of time for a consequence.

(*a*) If this happens in the way that high earnings lead to slackness—and this has certainly been so among the less responsible employees in many places—the case is not practically, though it is theoretically, very different from that just considered; and the same remedy is indicated.

(*b*) In so far as long hours lead to loss of time by fatigue and sickness, insistence upon them is most deplorable. The keenest men are not always the most robust, and it is the keenest who have most strain to bear. The hours gained are more costly than the hours lost, and, coming as a rule at the end of a long day, their cost is altogether disproportionate to their output; and the resulting fatigue which drives some men to bed produces lassitude and decreased efficiency in many of those who continue to attend regularly, so that the output of normal hours also declines. The effects of Sunday labour are, as has now been recognized, still worse than those of overtime hours in the evening or on Saturday afternoon.

12. How considerable a proportion of the time gained by extraordinary hours may be lost in normal hours even in a well-managed factory in which the goodwill of the employees is undisputed, is illustrated by the following figures which refer to the engineering departments of a firm engaged on heavy work. The normal dayshift week is 53 hours, and the nightshift week 60 hours.

TABLE I.

Period.	Percentage of Employees working overtime.	Average hours worked overtime by those so working.	Percentage ratio of hours worked overtime to practically possible normal hours of all employees.	Percentage of Employees working on Sunday.	Percentage ratio of Sunday hours to total overtime.	Percentage ratio of hours lost by bad timekeeping and sickness to hours gained by work overtime.
May, 1916 (4 weeks) ...	78·4	13·0	19·7	62·0	61·0	53·0
June, 1916 (2 weeks)...	72·0	12·7	16·9	60·0	57·0	59·6

The high percentage of loss is mainly attributable to a very high sickness rate, itself the result of long hours on heavy work since the beginning of the war. Further figures illustrating this point will be quoted below (*cp.* especially Table II.).

Obviously, however, a mere comparison of hours gained by overtime and normal hours lost is worthless if unaccompanied by other figures; since if little overtime be worked, it may be more than counterbalanced by a very moderate loss of normal time, not in any way due to the overtime work.

13. The very long hours worked in many factories during the past two years have, perhaps, been necessary, but, so far as my experience goes, the necessity has been imposed upon, and is deplored by, employers and managers, who have noted the decreasing briskness and resilience of the workers. The strain has told, not only upon operatives, but still more upon officials and upon foremen, who have broken down in considerable numbers. Unhappily, the men too often welcome long hours because of the extra pay. In one factory, where overtime had been kept as low as possible, men told me quite frankly that there was a good deal of grumbling in consequence. But the sickness-rate in that factory was correspondingly low, and there can be no doubt that for the average man high wages earned by long hours are too dearly earned.

II.—SICKNESS.

(*a*) The Differentiation of Bad Timekeeping and Sickness, and of Avoidable and Unavoidable Lost Time.

14. Of firms which keep a continuous record of lost time only a small minority attempt to determine accurately what proportion is due to sickness, or to distinguish accurately between avoidable and unavoidable loss of time. In some factories no distinction is tabulated at all;

sometimes it depends wholly on foremen's opinions; sometimes absence is classified as sickness only if a medical certificate is handed in, and certificates are carefully demanded; in other factories the word of trusted employees is accepted, and their absence classified under sickness; in others, again, their word is accepted, but their absence, in default of a certificate, is reckoned under bad timekeeping. Here all absences for less than two or three days are counted as bad timekeeping, but certificates are demanded after long absence; next door longer absences are simply assumed to be unavoidable, except in the case of notorious slackers.

15. One principal cause of the present confusion is the dissatisfaction of employers with *medical certificates*. This dissatisfaction is very wide-spread; it is not confined to any particular locality, or any particular size of town, or any particular kind of employment. Moreover, it is in the main justified. Upon analysis it resolves itself into two principal grievances:—

(1) Some certificates are given when they are not deserved. This must under any circumstances happen not infrequently, if a doctor has no data for his judgment beyond the statement of a man whom he has rarely, if ever, seen before. But, whilst this difficulty must be fully recognised, there is no doubt that some undeserved certificates are the result, not of excusable error, but of extreme slackness or some times of deliberate dishonesty upon the part of medical men. Unconscientious doctors are comparatively rare, but they are widely distributed; one or two are to be found in nearly every populous district; they find their mates in equally unconscientious employees (like themselves, a small minority of the whole); and they infect the minds of employers with a distrust which unfortunately reaches beyond themselves.

(2) Very many certificates, though honest, are so brief as to be practically useless. Often they state nothing beyond the bare fact that a man is unwell and unable to follow his employment. Now the employer would perhaps learn little from the name of the patient's complaint, but he is seriously interested to know, especially at the present time, whether the patient must leave work at once or may continue on something urgent for a few days, and also to know, if possible, how long he is likely to be away. On the other hand, a statement of the patient's age and of the nature of his complaint, though not always directly useful to the employer, would be of the utmost service to the investigation of industrial disease, supposing that certificates, when no longer required, were sent for tabulation to the Medical Research Committee.

16. Some advantage that would follow from more trustworthy and informative certificates are these:—

(1) Employers would receive information assisting them in the organisation and co-ordination of work, and so facilitating output;

(2) Employers would be encouraged to distinguish accurately sickness as a factor of lost time, and so to keep closer watch on the conditions of health among their employees; and

(3) There would be furnished data for a study of the statistics of industrial diseases.

The first is the most important point at this moment, but after the end of the war the second and third advantages will become increasingly important.

17. The need of improved certificates is urgent, both temporarily in reference to munition workers and afterwards permanently in reference to all employees in factories. Much could be done immediately by supplying a standard medical certificate to panel practitioners and other medical practitioners in the neighbourhood of munition factories and controlled establishments, with a request that the form be used for all certificates given to munition workers.

18. A result of defective records seems to be a very frequent underestimation of the part played by sickness as a factor of lost time, and generally of the proportion of unavoidable to avoidable loss of time.

19. The following table concerns a body of over 1,200 men (with a very few women) in an engineering department. Smithy and foundry are excluded from these figures, but the general character of the work is heavy (though, of course, some shops are exceptions), and in most weeks of the record there has been much work overtime, especially on Sundays. The figures for sickness refer to well-authenticated and for the most part to certified cases only, and accidents are left out of account; there is an inducement to employees to send in certificates when sick, and the record of sickness is carefully kept. The normal dayshift week is 53 hours and the nightshift week 60 hours.

TABLE II.

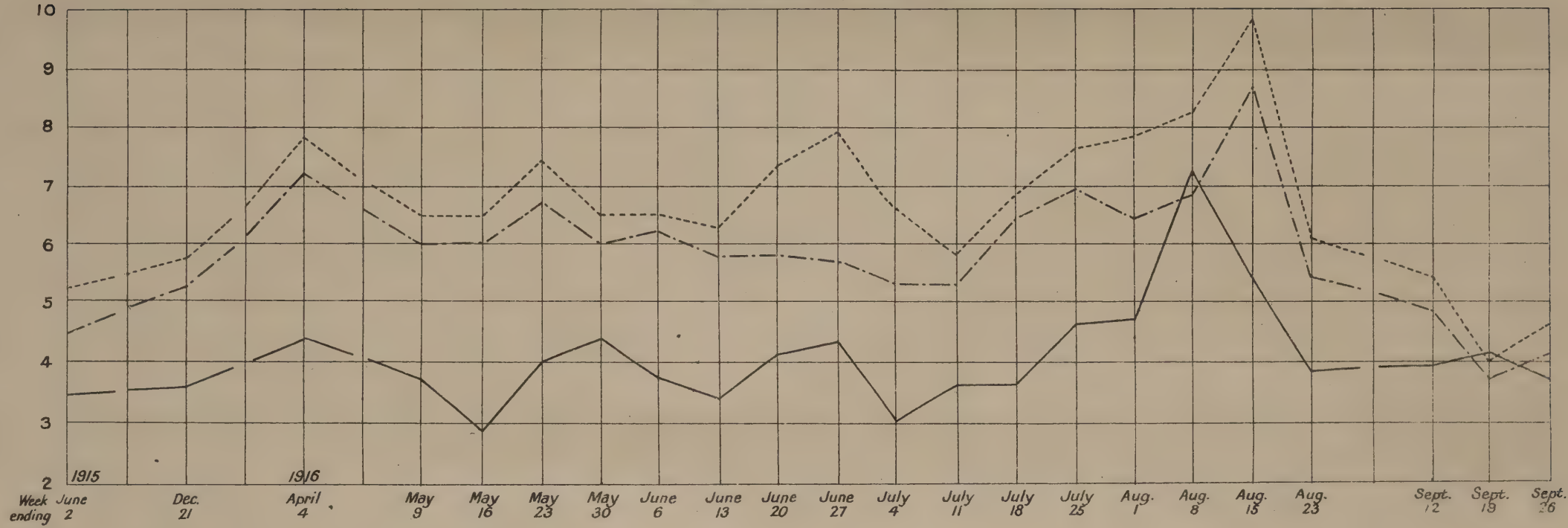
Week ending (1)	Percentage ratio of time lost by "bad timekeeping" to practically possible normal time. (2)	Percentage ratio of time lost by "bad timekeeping" to gross normal time less time lost by leave. (3)	Percentage ratio of time lost by sickness to gross normal time less time lost by leave. (4)	Percentage ratio of time lost by "bad timekeeping" to gross normal time. (5)	Percentage ratio of time lost by sickness and leave to gross normal time. (6)	Percentage ratio of total time lost to gross normal time. (7)	Percentage ratio of time lost by sickness to time lost by "bad timekeeping" and sickness. (8)	Percentage ratio of time lost by sickness and leave to total lost time. (9)	Average hours (normal and overtime) worked per employee. (10)	Notes.
1915.										
June 2 ...	3·5	3·3	4·5	3·3	5·3	8·6	57·3	61·5	61	
December 21	3·6	3·4	5·3	3·4	5·8	9·2	60·7	63·0	—	
1916.										
April 4 ...	4·4	4·0	7·2	4·0	7·8	11·9	64·0	66·0	$56\frac{1}{2}$	
May 9 ...	3·7	3·4	6·0	3·4	6·5	9·9	63·2	65·2	$58\frac{1}{5}$	
„ 16 ...	2·9	2·7	6·0	2·7	6·5	9·2	68·6	70·2	$59\frac{1}{3}$	
„ 23 ...	4·0	3·7	6·7	3·7	7·4	11·2	64·1	66·4	$55\frac{1}{5}$	Daylight saving.
„ 30 ...	4·4	4·1	6·0	4·1	6·5	10·7	59·1	61·2	58	
June 6 ...	3·7	3·5	6·2	3·5	6·5	10·0	63·6	64·8	$59\frac{1}{3}$	
„ 13 ...	3·4	3·2	5·8	3·2	6·3	9·6	63·9	66·0	$57\frac{1}{5}$	Extra pay on Whit Monday.
„ 20 ...	4·1	3·8	5·8	3·8	7·3	11·1	60·1	66·0	57	
„ 27 ...	4·3	4·0	5·7	3·9	7·9	11·8	58·8	66·6	$56\frac{1}{2}$	Extra pay on June 27 and 28.
July 4 ...	3·0	2·8	5·3	2·8	6·6	9·5	65·0	71·6	$58\frac{1}{2}$	
„ 11 ...	3·6	3·4	5·3	3·4	5·8	9·2	60·7	62·6	$58\frac{3}{4}$	
„ 18 ...	3·6	3·5	6·4	3·4	6·8	10·3	64·7	66·4	$57\frac{3}{5}$	
„ 25 ...	4·6	4·3	6·9	4·3	7·6	11·9	61·4	62·5	$56\frac{1}{2}$	
August 1 ...	4·7	4·4	6·4	4·3	7·8	12·2	59·0	64·0	$55\frac{1}{5}$	
„ 8 ...	7·2	6·7	6·8	6·6	8·2	14·8	50·5	55·4	$48\frac{1}{5}$	Extra pay on the 7th. Overtime much reduced; little Sunday work.
„ 15 ...	5·4	4·9	8·6	4·9	9·8	14·7	63·5	65·6	$48\frac{1}{4}$	
„ 23 ...	3·8	3·6	5·4	3·6	6·1	9·7	59·8	62·6	—	An extra day in this pay.
									—	Holidays from Aug. 26 to Sept. 4.
September 12	3·9	3·7	4·8	3·6	5·4	9·0	56·8	59·5	57	
„ 19	4·1	3·9	3·7	3·9	4·0	8·0	48·3	50·1	$55\frac{3}{4}$	
„ 26	3·7	3·5	4·1	3·5	4·6	8·1	43·6	56·8	$57\frac{2}{5}$	

20. In every week recorded save one the proportion of lost time, apart from absences with leave, due to sickness alone (column 8) is more than a half, and in most weeks it is over 60 per cent., whilst in all weeks certified sickness and leave together (column 9) account for more than half the total time lost, and in all weeks save four they account for over 60 per cent. of it, and twice for over 70 per cent. of it. The part played by these factors is diminished on two occasions, and then for two opposite reasons. In the first part of August there was less urgency of work, and the men, knowing this, were inclined to take a rest to which the time of year also prompted them, so that "bad timekeeping" increased; and after the holidays at the end of August there was a remarkable improvement in health.

21. It is doubtful, however, whether even the careful records kept by the firm to whom these figures refer do complete justice to the facts. There remains the possibility that some part of what is reckoned as "bad timekeeping" is due to fatigue and minor ailments which are genuine enough, though no one would ask for or give a medical certificate in respect of them. If that be so, the curves of "bad timekeeping" and of sickness will tend to move in the same direction. Now, in Diagram I., which represents graphically columns 2, 4 and 6 of Table II., this tendency is apparent: the curve of "bad timekeeping" does on the whole move in the same direction either as the curve of sickness or (*e.g.*, at the end of June, when a generous amount of leave was granted for the sake of the men's health) as the curve of sickness and leave combined. But after the holidays at the end of August, there is no such coincidence. It seems likely, therefore, that during the main period the figures of "bad timekeeping"

DIAGRAM I.

---------- Ratio of sickness plus leave to gross normal hours.
—·—·—·—·— " " " to gross normal hours less leave.
———————— " " bad timekeeping to practically possible normal hours.



5979. 56590/3502.,8000. 4. 17.

Malby & Sons Lith

include some absences which should be attributed to a sort of invalidity rather than to slackness. This is specially likely to be true of lost "quarters," which, in the steadiest shops, account for a very great part of the so-called bad timekeeping in this factory.*

22. In the attempt to ascertain by a comparison of curves whether the figures of "bad timekeeping" includes absences due to physical disabilities of a minor kind, it is more important to notice whether the curves rise than whether they fall concomitantly, especially when hours are long, for the factors which first produce absences deemed avoidable may go on to produce definite sickness, and thus the curve of bad timekeeping may fall whilst that of sickness rises, simply because those are now declared sick who were previously "off-colour." In other words, it is sometimes necessary to observe whether a rise in the bad timekeeping curve is followed, rather than accompanied, by a rise in the sickness rate. In the records of one factory employing about 950 males I examined the figures for 58 successive weeks. After setting aside 8 weeks in which they were seriously affected by holidays, I found that in the remaining 50 the curve of bad timekeeping rose 24 times. In 13 of those 24 weeks the rise was accompanied by an increase of recorded sickness; in 7 weeks by a fall; whilst 4 times the sickness-rate was unchanged. On 6 of the 7 occasions when the rise in bad timekeeping was accompanied by a fall in sickness, and on 3 of the 4 occasions when there was no simultaneous movement in the sickness-curve, the amount of sickness increased in the following week. I had other reasons for supposing that sickness was considerably understated in this factory, and these figures confirmed the supposition. Where the facts of sickness are more carefully ascertained and the doubt is only concerning minor ailments, such definite figures are scarcely to be expected.†

23. It might be supposed that so high a proportion of unavoidable lost time as that given in Table II. is peculiar to heavy work carried on at very high pressure, but the following table shows that this is not necessarily true. It refers to a body of about 270 males and 290 females engaged upon light work in one department of a large factory. Sickness is not separately recorded, but careful enquiries are made into the reasons for all lateness or absence. More than half the lost time, and usually much more than half, is lost unavoidably. It will also be noticed that, though the total time lost by the females is higher than that lost by the males, the proportion unavoidably lost by the females is also higher in most weeks.

TABLE III.

Week ending (1)	Percentage ratio of time lost avoidably to practically possible normal time. (2)		Percentage ratio of time lost avoidably to gross normal time, taken as 52½ hours a week per employee (3)		Percentage ratio of time lost unavoidably to gross normal time. (4)		Percentage ratio of total time lost to gross normal time. (5)			Percentage ratio of time lost unavoidably to total time lost. (6)	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	All.	Males.	Females.
1916.											
June 6 ...	2·4	1·4	2·3	1·3	2·6	3·7	5·0	5·0	5·0	52·9	73·2
„ 13 ...	2·0	1·0	1·9	1·0	2·8	4·3	4·9	5·3	5·2	50·9	81·0
„ 20 ...	1·8	2·0	1·7	1·9	4·9	5·2	6·7	7·1	6·9	73·0	72·9
„ 27 ...	2·1	1·9	2·0	1·7	4·8	7·5	6·9	9·2	8·1	70·0	81·0
July 4 ...	2·0	1·4	2·0	1·3	2·7	6·2	4·7	7·6	6·2	58·0	82·1
„ 11 ...	1·9	2·3	1·8	2·2	4·6	6·9	6·5	9·1	7·9	71·2	75·7
„ 18 ...	2·5	1·8	2·4	1·7	3·5	7·2	5·9	8·9	7·5	69·8	80·9
„ 25 ...	2·5	2·0	2·4	1·9	3·9	7·3	6·3	9·3	7·9	61·1	79·1
August 1 ...	1·8	2·7	1·8	2·5	4·2	7·2	6·0	9·7	7·9	69·8	73·9
„ 8 ...	1·3	1·2	1·3	1·2	3·5	5·3	4·8	6·6	5·7	73·0	81·5
„ 15 ...	2·1	1·5	2·0	1·5	4·5	4·7	6·6	6·2	6·4	69·5	76·0
„ 22 ...	1·3	2·4	1·2	2·2	3·2	5·8	4·4	8·0	6·2	71·8	71·9
„ 29 ...	Department closed.										
September 8...	1·8	2·6	1·7	2·4	3·0	5·6	4·8	8·1	6·5	63·2	69·3
„ 12...	1·5	2·9	1·5	2·7	2·8	4·0	4·4	6·8	5·6	65·1	59·4
„ 19...	1·8	1·6	1·7	1·5	2·6	5·0	4·4	6·5	5·5	60·2	76·4
Average for the period ...	1·9	1·9	1·9	1·8	3·6	5·7	5·5	7·6	6·6	65·7	75·8

In only two other factories besides those to which Tables II. and III. refer have I up to the present discovered figures of sickness or unavoidable absence generally that appear to me

* *See* below (pars. 33 (5) and 47) the figures of timekeeping for certain heavy machine shops.

† Further data concerning the correlation or lack of correlation between figures of bad timekeeping and of sickness are desirable; and I should be glad if any employer interested in the subject, who keeps carefully collected and tabulated records, would communicate with me through the Secretary of the Committee and would allow me to inspect them.

reasonably trustworthy. Both are small factories, engaged on moderately heavy work, with moderate overtime. In one, employing about 240 men, the total loss of possible time for 12 months to the end of September, 1916, was 7·27 per cent., and sickness alone accounted for 54 per cent. of this loss. In the other, the total loss in a period of August, 1916, among about 130 men in the engineering and tool shops was 5 per cent.; sickness accounted for 46·7 of this loss and unavoidable causes generally for 59·9 per cent. of it.

24. In all these four places, then, where timekeeping was reasonably good and records were carefully made, *the unavoidable loss is more than half the total loss;* and the inference is, therefore, suggested that elsewhere also, unless attendance is very slack, more careful enquiry than is usually made into reasons for absence would reveal the same fact. Obviously, however, in factories where timekeeping is really bad, the proportions of time lost avoidably and unavoidably may be reversed. The following figures are of some interest in this connection, though in default of more precise informations as to the means of determining sickness and as to the precision of the returns, not much stress can be laid on them.

25. For the week ending February 4th, 1916 (a period in which lost time was likely to be considerable, and the sickness rate especially likely to be high), of 77 firms returning their time lost as not more than 6 per cent. of possible time, 56 attribute at least half to sickness (including accidents), and 21 attribute less than half of it to this cause; of 41 firms returning a percentage over 6 and not more than 10, 24 attribute at least half to sickness, and 17 attribute less; and of 25 firms whose employees lost more than 10 per cent. of possible time only 7 attribute more, and 18 attribute less, than half the loss to sickness.

26. The following tables are an example of records in a factory where the timekeeping was not satisfactory. Table IV. refers to an engineering department mostly engaged on heavy work except in some shell-shops; Table V. distinguishes the women-operatives in shell-shops, who were included in the preceding table; and Table VI., which refers to a shipbuilding department, is added for comparison. The record is for week ending March 4th, 1916, at which period a high percentage of lost time is to be expected, especially as overtime was considerable, the percentage ratio of hours worked overtime to practically possible normal hours being in the engineering department for the skilled dayshift 17·1, for the skilled nightshift 16·9, for the unskilled dayshift 17·4, and for the unskilled nightshift 22·4; among the women on day work 14·6, and on night work 23·3; and in the shipbuilding department for the skilled dayshift 19·1, for the skilled nightshift 13·5, for the unskilled dayshift 20·3, and for the unskilled night 21·2. The normal dayshift hours were in most shops except the shell-shops 53, and the normal nightshift hours 57½.

TABLE IV.

Grade and shift.	Number employed (approximately).	Percentage ratio of time lost avoidably to practically possible normal time.	Percentage ratio of time lost avoidably to gross normal time.	Percentage ratio of time lost unavoidably to gross normal time.	Percentage ratio of total time lost to gross normal time.	Percentage ratio of time lost unavoidably to total time lost.	Average hours (normal and overtime) worked per employee.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Skilled, dayshift (except shell shops).	4,500	11·0	10·4	5·2	15·7	33·1	52½
Skilled, dayshift, in shell-shops.	1,000	14·6	13·6	6·9	20·5	33·5	52⅓
All skilled, dayshift ...	5,500	11·7	11·0	5·5	16·5	33·2	52½
Skilled, nightshift (except shell-shops).	1,950	5·4	5·3	2·5	7·8	32·0	62
Skilled, nightshift, in shell-shops.	750	9·7	9·6	0·8	10·5	8·0	55
All skilled, nightshift..	2,700	6·5	6·3	2·1	8·4	24·9	60
All skilled employees..	8,200	9·8	9·4	4·3	13·8	31·5	55
Unskilled, dayshift (except shell-shops).	3,740	10·7	9·9	7·6	17·5	43·1	52¾
Unskilled, dayshift, in shell-shops.	4,930	10·6	10·2	3·2	13·4	24·0	48½
All unskilled, dayshift	8,670	10·6	10·0	5·2	15·3	34·1	50⅓
Unskilled, nightshift (except shell shops).	1,230	4·0	4·0	1·1	5·2	22·7	66¼
Unskilled, nightshift, in shell-shops.	3,150	10·5	10·2	2·7	12·9	21·1	47
All unskilled, night shift.	4,380	8·3	8·1	2·2	10·3	21·4	52½
All unskilled employees	13,050	9·8	9·4	4·2	13·7	31·0	51
All employees... ...	21,250	9·8	9·4	4·3	13·7	31·3	52⅗

TABLE V.

Grade and shift.	Number employed (approximately).	Percentage ratio of time lost avoidably to practically possible normal time.	Percentage ratio of time lost avoidably to gross normal time.	Percentage ratio of time lost unavoidably to gross normal time.	Percentage ratio of total time lost to gross normal time.	Percentage ratio of time lost unavoidably to total time lost.	Average hours (normal and overtime) worked per employee.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Women, day, in shell-shops.	2,600	8·6	8·4	1·9	10·4	19·0	42
Women, nights, in shell-shops.	1,170	12·3	12·2	1·0	13·3	7·6	$42\frac{3}{4}$
All women in shell-shops.	3,770	9·8	9·6	1·7	11·3	14·5	$42\frac{1}{4}$

TABLE VI.

Grade and shift	Number employed (approximately).	Percentage ratio of time lost avoidably to practically possible normal time.	Percentage ratio of time lost avoidably to gross normal time.	Percentage ratio of time lost unavoidably to gross normal time.	Percentage ratio of total time lost to gross normal time.	Percentage ratio of time lost unavoidably to total time lost.	Average hours (normal and overtime) worked per employee.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Skilled, dayshift ...	2,530	17·3	16·5	5·1	21·6	23·4	$50\frac{1}{5}$
Skilled, nightshift ...	360	11·6	11·3	2·4	13·7	17·0	$57\frac{4}{5}$
Unskilled, dayshift ...	1,260	19·6	18·9	3·9	22·8	17·4	51
Unskilled, nightshift...	160	7·8	7·8	—	7·8	0·0	69
All employees... ...	4,310	17·0	16·2	3·6	19·8	20·8	52

27. The percentage of possible time lost is throughout high, the proportion ranked as unavoidably low. A low proportion of unavoidable loss is to be expected on nightshift, since employees who are obviously "off-colour" will, as far as possible, be kept on day work, if the management is sensible; but here even on dayshift the unavoidable loss is barely more than a third of the total lost time. That it has been underestimated is a reasonable conjecture; but it probably was well under half the total loss, for attendance was evidently slack. It is noticeable that the "unavoidable" proportion is markedly higher among unskilled than among skilled men on dayshift except in the shell-shops where (allowance being made for the women's bad timekeeping) the men's records are nearly the same for skilled and unskilled. In the very bad figures of the shipbuilding department, however, this difference is not repeated.

28. It might be expected that the most accurate records of unavoidably lost time would be those based on the records of foremen or officials who have satisfied themselves concerning reasons offered for absence. In fact, however, such records are not very trustworthy except where some superior official, *e.g.*, a departmental manager, takes an interest in the matter, as in the department to which Table III. refers. Foremen vary in strictness, and sometimes in personal preference; and those employees who are trusted and know themselves to be in no danger of the Tribunal often fail to report their quite valid reasons for absence. Moreover, in large factories foremen often forget to enter a note of sound reasons, which accordingly never reach the time office.

29. The payment of a bonus for good timekeeping, against which sickness does not rank, is more likely to ensure good data for records, by making it worth employees' while to send in certificates when they are ill. Even the payment of a bonus, however, does not guarantee absolute accuracy. Where there is a keen and reputable body of employees, the few cases of dishonest certificates will be balanced by the few cases in which men forget, or having already lost time unduly do not think it worth while, to send in certificates though genuinely sick. But there remains the likelihood that some proportion of what is reckoned as bad timekeeping is due to minor ailments; and a further cause of inaccuracy arises if attendance is slack and if a number of the employees are able to earn wages much higher than those to which they are used, the result being sometimes that they are indifferent to the bonus and careless about sending in certificates. (To a certain extent the Tribunals have checked such carelessness and so have indirectly improved records.) The following figures relating to about 200 men on very heavy work are an illustration. Their normal dayshift was 53 hours; only three or four men were on nightshift; overtime was moderate, about 40 to 60 per cent. of the men averaging nine hours each (80 per cent. in June, 1915), and there was practically no work on Sundays. Whilst they are probably a hardier lot of men than those in most machine shops and the like, and whilst their undoubtedly bad timekeeping has very likely helped to keep down sickness, still it is most improbable that the proportion of lost time due to sickness in 1915 is accurately given in column 8. It is evident that they have been induced both to keep better time and to

report sickness more carefully, though it is possible that even the 1916 figures understate the real amount of sickness.

TABLE VII.

Week ending. (1)	Percentage ratio of time lost by "bad timekeeping" to practically possible normal time. (2)	Percentage ratio of time lost by "bad timekeeping" to gross normal time, less leave. (3)	Percentage ratio of time lost by sickness to gross normal time, less leave. (4)	Percentage ratio of time lost by "bad timekeeping" to gross normal time. (5)	Percentage ratio of time lost by sickness and leave to gross normal time. (6)	Percentage ratio of total time lost to gross normal time. (7)	Percentage ratio of time lost by sickness to time lost by "bad time-keeping" and sickness. (8)	Percentage ratio of time lost by sickness and leave to total lost time. (9)	Average hours (normal and overtime) worked per employee. (10)
1915.									
June 2 ...	13·9	13·7	1·7	13·6	2·2	15·8	11·4	13·9	51
December 21 ...	15·6	15·6	1·3	15·4	1·7	17·1	7·9	10·0	—
1916.									
April 4 ...	9·9	9·5	4·1	9·5	4·3	13·8	30·0	31·0	49¼
May 9 ...	9·2	8·7	4·9	8·7	5·1	13·9	36·0	37·0	50½
„ 16 ...	8·5	8·1	5·0	8·1	5·0	13·1	38·3	38·3	51
„ 23 ...	9·9	9·3	5·0	9·2	5·1	14·4	34·9	35·7	51½
„ 30 ...	8·8	8·6	3·1	8·5	3·7	12·2	27·0	30·2	51
June 6 ...	10·4	9·9	4·3	9·9	4·5	14·5	30·2	31·5	50

30. An easy and frequently useful test of the accuracy of sickness-records is to compare the number of absences for a whole week recorded as due to sickness with the number of absences for shorter periods so recorded. It is common experience that one is more likely to be ill for a day or two than for a week, and this experience is reflected in accurate records. Thus in Table VIII., which refers to the same men as Table II., about 3 per cent. of the employees lost a whole week

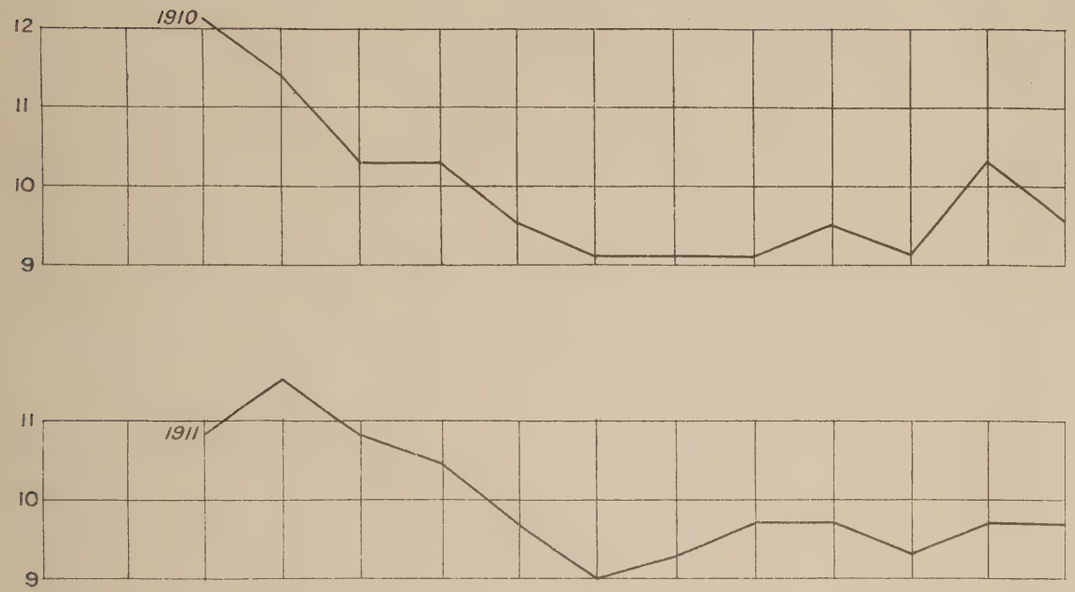
TABLE VIII.

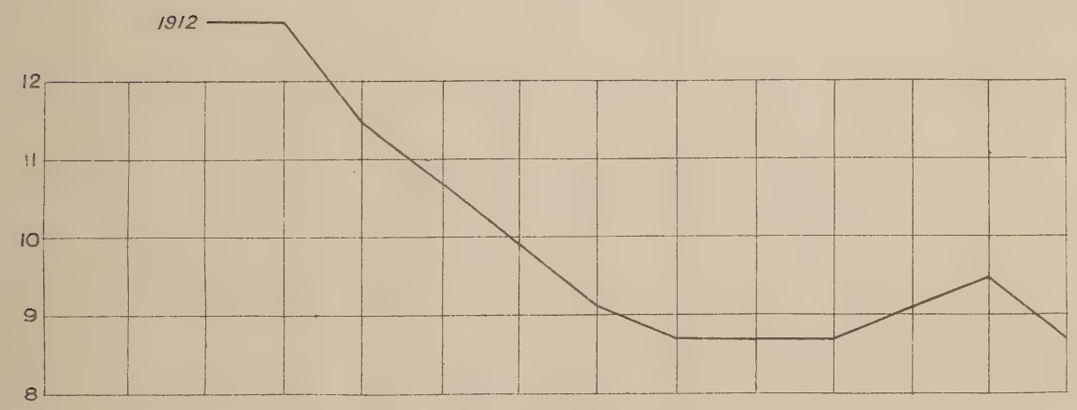
Week ending	Percentage of employees losing the whole week by sickness.	Percentage of employees losing any time by sickness.	Average number of hours lost by each employee who lost less than the whole week.
1915.			
June 2	2·2	9·2	18
1916.			
April 4	3·7	14·9	14¾
May 9	3·4	11·6	16½
„ 16	3·3	12·0	16¾
„ 23	3·4	12·9	17¼
„ 30	3·3	12·1	16¾
June 6	3·0	12·4	18¾

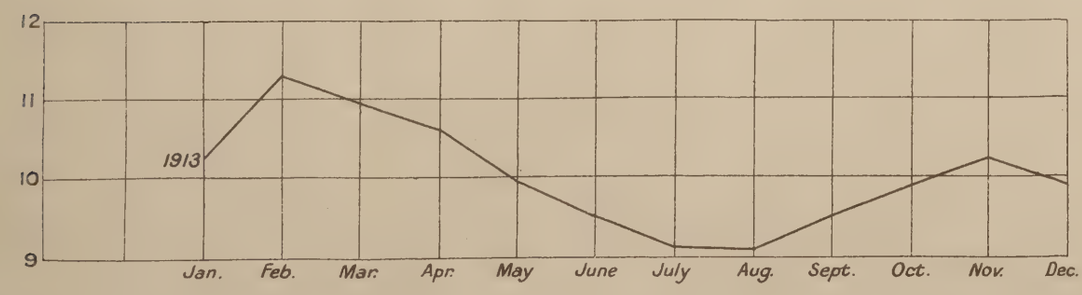
from sickness in May and June, 1916, whilst nearly three times as many were sick for shorter periods. Even among the men just mentioned in Table VII. the average figures for the weeks of May were—absent sick the whole week 2·9 per cent., less than the whole week 4·4 per cent. If then weeks lost by sickness are found in records to equal or outnumber the shorter periods, it is probable that employees are not troubling to report genuine sickness unless it is worth their while for other reasons to obtain certificates. For example, in one factory 134 men are recorded as losing in nine weeks of August, September and October, 1916, 17 weeks or longer periods by sickness and only nine periods of less than a week. This was a case in which the payment of a (rather small) bonus for good timekeeping to a limited number of examiners, specially important mechanics, &c., had very little effect; the 134 whose records were examined by Mr. S. H. Burchell and myself lost in those weeks 10·6 per cent. of possible normal time, allowance being made for leave, accidents, and the like, 2·1 per cent. being attributed to sickness and 8·5 per cent. regarded as avoidable. Timekeeping was certainly bad, but the test suggested makes it certain that a considerable amount of sickness remained unrecorded, despite the bonus.

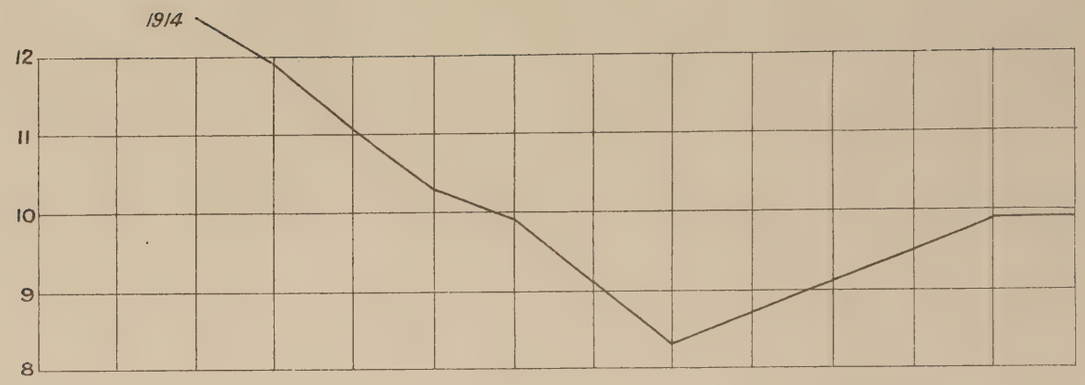
31. Another test of the accuracy with which sickness is discriminated from bad-timekeeping enquire whether the time recorded as avoidably lost in days is abnormally high in proportion to

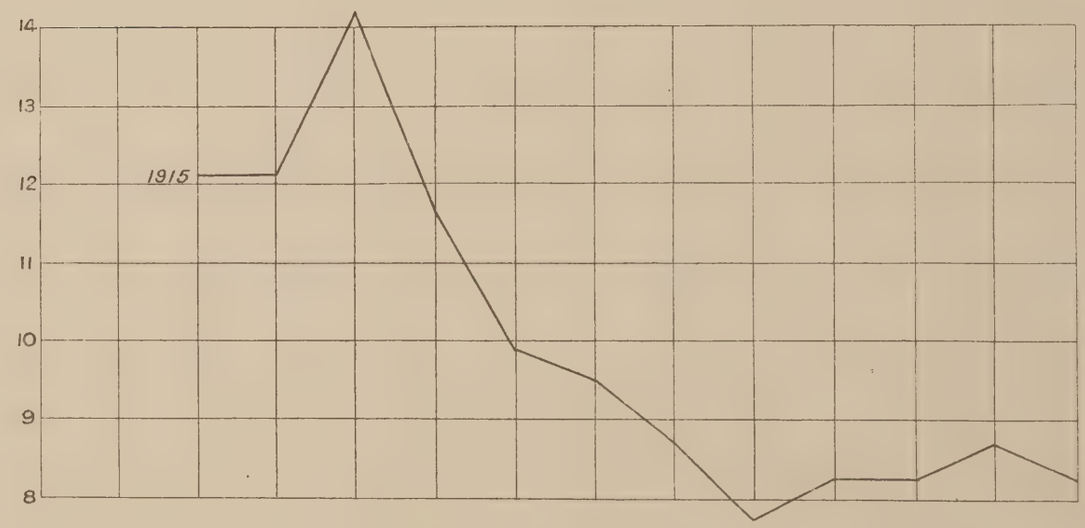
DIAGRAM II.

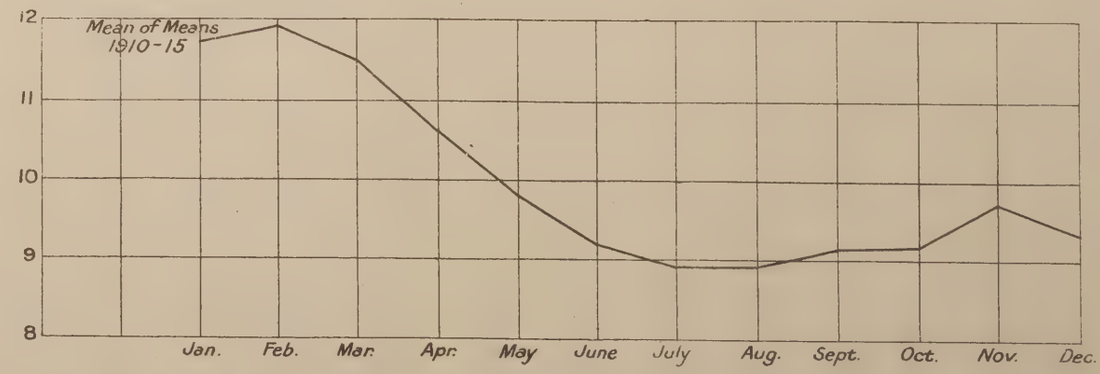












5979

Malby&Sons, Lith.

the time recorded as avoidably lost in "quarters," where the two-break dayshift is worked; for in that case the days reckoned as avoidably lost very likely include some lost by sickness. This test is useless if attendance is very slack and men are wilfully missing days in great numbers*; but when timekeeping is reasonably good the loss before breakfast may be expected to be *at least* 35 per cent. of the total avoidable loss. If it is less than that, and if the ratio of unavoidable loss to total loss is also low, the sickness-record may be regarded with suspicion.

32. My conclusions may be summarised as follows:—

(1) Sickness records which suggest that even the best-managed factories are health-resorts are probably untrustworthy. *Nearly all records understate, and most records understate greatly, the proportion of lost time due to sickness and other unavoidable causes.*

(2) The main reason for the unsatisfactory sickness-records is employers' distrust of medical certificates.

(3) On other and practically urgent grounds *it is imperative to improve the form and the credit of medical certificates.*

(4) The best *tests of the accuracy of sickness-records* are to enquire:

(*a*) Do the curves of bad timekeeping and sickness coincide in direction?

(*b*) Is the number of whole weeks lost through sickness abnormally high when compared with the number of shorter periods similarly lost?

(*c*) Is the number of days lost through sickness abnormally high when compared with the number of quarters similarly lost?

An affirmative answer to any of these questions, unless explicable otherwise, gives good reason for supposing the rate of sickness to be understated.

More definite conclusions are not to be expected with the present unsatisfactory medical certificates and consequently defective records. But it should be noted that, whilst in some places and in some trades time-keeping has really been slack, yet the underestimation of sickness and unavoidable absence generally has led to much misinformed and unjust rhetoric about the lethargy and irregularity of the whole body of employees in controlled factories. The chief offenders in this matter, however, have not been employers.

(*b*) Some Causes of Fluctuation in Sickness-Curves.

33. The following notes are not concerned with a comparison between different factories or different occupations, nor with those factors of sickness that may be regarded as constants in any given factory, but with a few of the variables which produce conspicuous temporary changes in the rate of sickness in any given factory.

(1) *Climatic Conditions.*—It is, of course, a familiar fact that fluctuations in the sickness rate are mainly seasonal. The graphs in Diagram II. are based on the statistics of a large and very important Trade Union concerning the percentage of members on sick benefit in each month of the years 1910 to 1915. That the curves for different years may be comparable one with another, the mean of the percentages of members on sick benefit in the months of each year has been found and taken as = 10, and *the variation of each month from the mean for the year is shown as a variation from 10.* The curves are comparable, therefore, only in respect of their form, and not in respect of the total amounts of sickness in the several years. There is added a typical curve for the six years, showing the mean monthly variations from the mean of the means of these years. The rate of sickness is always above the mean in January, February, March and April, and occasionally so in November; in the remaining seven months it is always below the mean; July and August usually show least sickness.† Despite minor irregularities and great differences in the amount of the mean variations, the curves are generally very similar, especially in respect of the fall in late spring and early summer and of the tendency to rise in November.

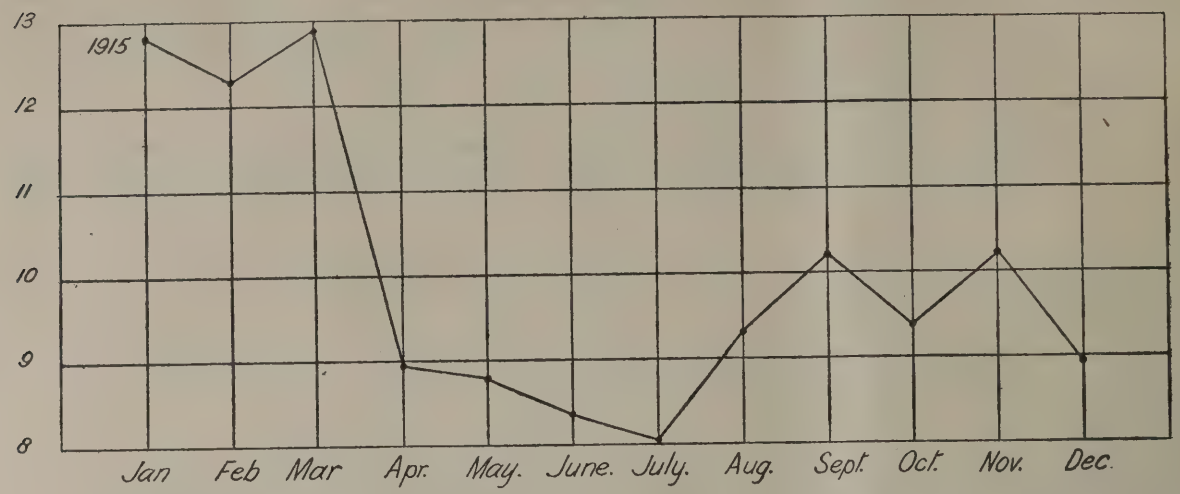
The figures upon which these curves are based refer to all parts of the country. Diagram III. refers to a factory near London, with about 8,000 employees on light work, and shows the fluctuations in the sickness-rate for 1915, calculated in the same way. The general features are similar, though the effect of the onset of spring is more marked, and the hot weather of August

* Or if there is no work owing to lack of material, and men are not discouraged from taking days off, since if they attended and were refused work on consecutive days, they might claim leaving-certificates!

† This is probably due in part to holidays. In some localities and in many kinds of work, the hot weather brings an increase over the sickness-rate of June. Holidays may also account in part for the low December levels.

has had an unfavourable effect. The marked rise in the sickness rate for September does not appear to be genuine, but to have been the result of air-raids.

DIAGRAM III.



In Diagram IV. are given extracts from the curves of sickness among over 900 males in a factory in North-East England which further illustrate the close dependence of health on climatic conditions. They represent absolute numbers of employees sending in medical certificates, but as only the form of the curves is here of interest, the absolute numbers are replaced by letters. The curves reflect the conditions of weather with remarkable fidelity. In both Novembers the weather was bad in the middle of the month, and then improved again. In both years, as is usual in that district, mid-winter was less inclement than the later part of February and March. In 1916 January was unusually mild and bright, but the weather broke in the first part of February and remained cold and for the most part wet and sunless till the middle of April. In 1915 the advent of spring-like weather was at the beginning of April, and correspondingly the curve declines a fortnight earlier than in 1916.

The general influence of climatic conditions upon health being admitted, it follows that if the sickness curve of a factory, though calculated with reasonable accuracy, does not respond to considerable changes in the weather, or fluctuates independently of the weather, there are present other determining conditions which deserve consideration by the management.

(2) Of these, one of the most conspicuous, though not of the most important, is *the approach of holidays*, which very frequently occasions a reduction in the sickness rate. This reduction is most marked before Christmas, and by no means always occurs before other holidays. The following table shows the character of changes before holidays in the sickness curves of two factories, one near London, the other in North-East England. (R = rise in sickness rate, F = fall, S = steady.) The week in which the holiday actually occurs or begins is not included, as for a number of obvious reasons the records of the broken week itself are unreliable; as a rule, though not always, it is marked by a fall in the curve.

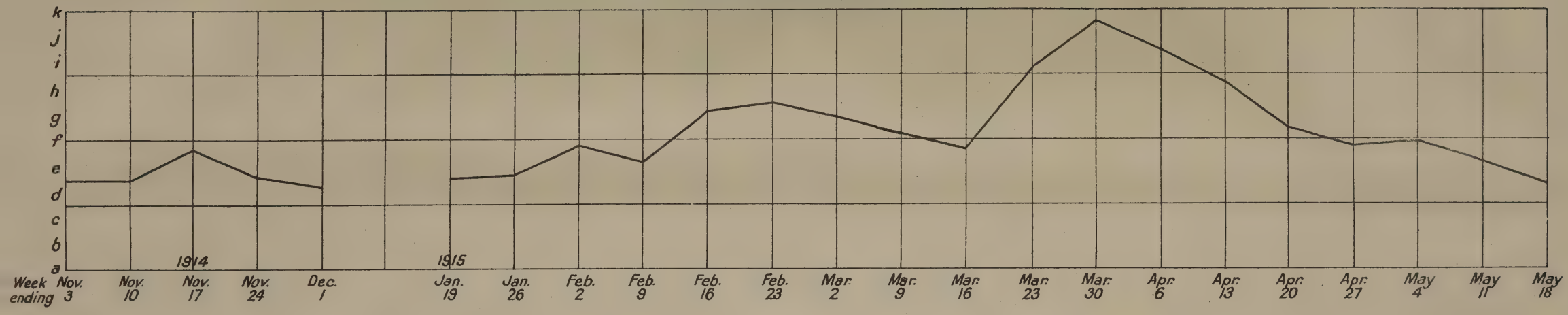
TABLE IX.

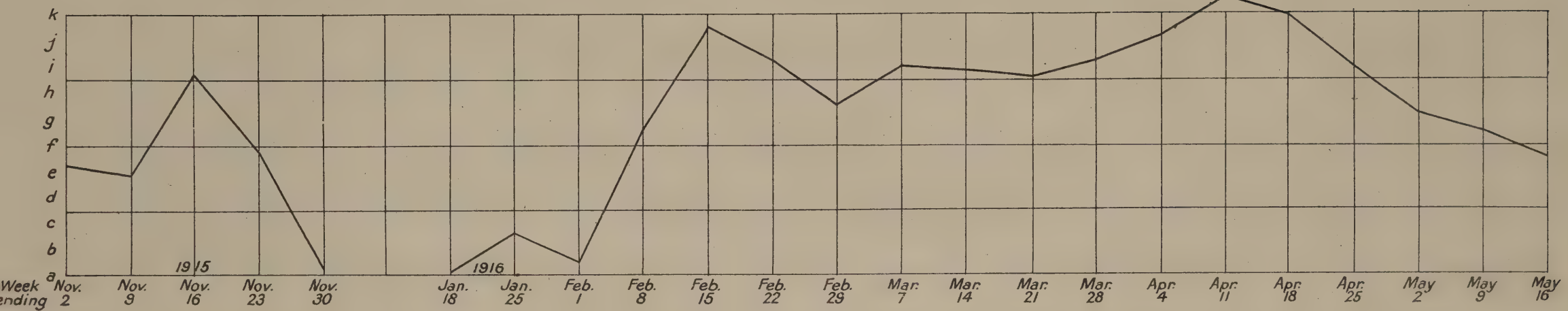
Firm.	Year.	Before Easter.		Before Whitsun.		Before King's Birthday.		Before Race-Week (end of June).		Before August Holiday.		Before Christmas.	
		2nd Week.	1st Week.	2nd Week.	1st Week.	2nd Week.	1st Week.	2nd Week.	1st Week.	2nd Week.	1st Week.	2nd Week.	1st Week.
I. ...	1914	R	R	R	R	R	R	—	—	S	R	F	F
I. ...	1915	F	F	No holiday.		—	—	—	—	F	F	F	S
II. ...	1914	—	—	—	—	—	—	—	—	—	—	F	F
II. ...	1915	R	R	F	F	—	—	R	F	F	R	F	F
II. ...	1916	F	F	—	—	—	—	—	—	—	—	—	—

With these data may be compared the marked fall of the sickness rate for week ending August 23rd, 1916, in Table II.; but it is impossible to say how much of this fall is attributable to approaching holidays, and how much to restriction of Sunday labour in the preceding fortnight.

The drop in sickness curves before the longer holidays, and especially before Christmas, is sometimes taken to argue, if not malingering, at any rate an unjustifiable readiness of employees to "go sick" at other times; they can come down to work when they want to earn money before the holidays, and therefore they ought to have come down in previous weeks. This conclusion, though no doubt true of some persons in any large body of employees, does not follow from the data and is probably unjust, if generally applied. For, in the first place, it sometimes happens that the Easter and Christmas holidays occur at a time when the sickness curve would in any

DIAGRAM IV.





5978.

Malby & Sons, Lith.

case decline—Easter, when spring is setting in, and Christmas, when the characteristic outbreak of sickness is over that occurs in mid-November, and people are becoming more acclimatised to the weather of late autumn and early winter. And, secondly, it does not follow because a man, whilst feeling unwell, goes down to work when a holiday is coming within a week or two, that therefore he would be judicious or would be able to carry on were he, under the same conditions of health, to go to work with no prospect of a break.

(3) A more important factor of change in a sickness-curve is a *holiday just past*. It should cause a fall, and usually does so, as is shown in the next table, in which the sickness-rate of the week following that in which the holiday occurs or ends is compared with the rate of the week preceding that in which the holiday occurs or begins.

TABLE X.

Firm.	Year.	After Christmas and New Year.	After Easter.	After Whitsun.	After King's Birthday.	After Race Week.	After August Holiday.
I	1914	—	R	F	F	—	F
I	1915	R	F	—	—	—	R
I	1916	F	—	—	—	—	—
II	1915	R	F	R	—	F	F
II	1916	F	F	—	—	—	—

A very striking example of the restorative effect of a holiday is to be found in Table II., when the sickness-rate for the three weeks immediately following a considerable holiday at the end of August and beginning of September is 4·2 per cent., as against 5·4 per cent. in the week immediately preceding the holiday, and 8·6 per cent. in the week before that; it had not been so low for many months previously.

It follows here that if the sickness-curve fails to respond to a holiday, especially to a break of several days, and if its steadiness or rise cannot be attributed to worsened climatic conditions, epidemics of influenza, or the like, there is reason for receiving employees' reports of sickness with caution, and sometimes with suspicion.

(4) *Patriotic enthusiasm* certainly affects sickness-curves. There are many employees who will keep at work when they are convinced of its urgency, even though they are unwell and really need the rest which they take when the urgent demand for their labour is past. This factor can seldom be illustrated by figures, but an example will be found in Table II.: the reduction of overtime in the first half of August, after a long period of very heavy pressure, indicated that some relaxation of effort was allowable, and not only the bad timekeeping, but the sickness-rate also, rose to a very high figure. Several managers have expressed their sense of the devotion of many of their employees, though some of them (but some only) consider that the readiness to "go sick" on comparatively slight grounds is now again more frequent than it was in the early stages of the war, and that there is now little difference in this respect from times of peace. For this, in addition to the familiar difficulty of maintaining an exalted mood indefinitely, there are in some cases two special reasons: firstly, that long hours of work have diminished the men's resilience, and, secondly, that they have too often been told that a piece of work was specially urgent and been pressed to stick to it against the interests of their health, and then have seen the completed product of their labour lying for weeks in the factory before removal. This failure to remove what has been made at high pressure produces incredulity and has a lamentable effect upon attendance.

(5) The effect of *long hours*, *much overtime*, and especially of *Sunday labour*, upon health is undoubtedly most deleterious. In one factory in the Midlands, when there was much Sunday work in the Spring, no fewer than 22 per cent. of the men were at one time sick; but the number of men on the sick-list in August, when Sunday work had been much reduced (though overtime on week-days remained heavy), was only a trifle over 4 per cent. of the whole body. This enormous reduction is partly attributable to the change of season, but the figures of a neighbouring factory showed that in that district last spring, though inclement, was not abnormally unhealthy, and I see no reason to doubt the manager's view that the weather was less accountable than the restriction of Sunday work.

Excessively long hours, and especially Sunday work, are similarly responsible for the high sickness figures in Tables II. and VIII., and for the remarkable reluctance of the sickness-curve to drop with the improving weather. Neither the loss of men to the Forces, which took place chiefly early in the war, nor the introduction of a small number of women (about 40) accounts for the rise between 1915 and 1916, and the 1915 figures themselves are not particularly low. There appears to be in these figures clear evidence of increasing strain due to incessant work.

Further analysis, however, discovers a striking difference between different departments in this factory. The following table refers to a body of about 180 extremely keen and steady men in heavy machine shops. In June, 1916, their average age was about 39 years, but

40 of the men were between 50 and 70 years of age. Roughly, 80 were skilled, 60 semi-skilled, and 40 unskilled. The nightshift was large, and overtime was severe, especially on Sundays. The amount of time lost avoidably was wonderfully low, considering the nature of the work, but the total time lost shows a great increase, owing to the remarkable rise in the sickness-rate.

TABLE XI.

Week ending (1)	Percentage ratio of normal hours worked on nightshift to total normal hours actually worked. (2)	Percentage of employees on overtime at all. (3)	Percentage ratio of hours worked overtime to practically possible normal hours. (4)	Percentage of employees working on Sunday. (5)	Percentage ratio of hours worked on Sunday to total hours worked overtime. (6)	Percentage ratio of hours lost by "bad timekeeping" to practically possible normal hours. (7)	Percentage ratio of hours lost by sickness to gross normal hours less leave. (8)	Percentage ratio of hours lost by "bad timekeeping" and sickness to gross normal hours less leave. (9)	Average hours (normal and overtime) worked per employee. (10)
1915.					*				
June 2 ...	43·8	91·7	23·9	—	—	1·3	3·1	4·5	65½
1916.									
April 4 ...	42·9	—	20·3	—	—	2·3	7·8	9·9	57¾
May 9 ...	42·3	87·0	21·1	—	—	1·4	6·4	7·3	62
„ 16 ...	41·5	85·9	20·8	—	—	1·1	7·0	8·1	61¾
„ 23 ...	41·4	83·5	21·0	81·2	71·0	1·6	8·3	9·9	61
„ 30 ...	41·5	79·8	20·2	74·8	67·5	2·4	8·0	10·2	59¾
June 6 ...	40·0	83·6	19·6	81·9	68·9	1·4	8·4	9·7	60
„ 13 ...	43·6	83·2	19·6	80·0	72·0	1·6	6·9	8·4	60½
„ 20 ...	43·2	83·3	19·2	80·0	74·5	2·7	6·8	9·3	59½

The next table concerns between 300 and 400 men on heavy work in shops with considerable smaller nightshifts and Sunday shifts. The record is in all respects less regular, but there is again an increase in the sickness-rate, as well as in bad timekeeping, despite some reduction of overtime.

TABLE XII.

Week ending (1)	Percentage ratio of normal hours worked on night-shift to total normal hours actually worked. (2)	Percentage of employees on overtime at all. (3)	Percentage ratio of hours worked overtime to practically possible normal hours. (4)	Percentage of employees working on Sunday. (5)	Percentage ratio of hours worked on Sunday to total hours worked overtime. (6)	Percentage ratio of hours lost by "bad timekeeping" to practically possible normal hours. (7)	Percentage ratio of hours lost by sickness to gross normal hours less leave. (8)	Percentage ratio of hours lost by "bad timekeeping" and sickness to gross hours less leave. (9)	Average hours (normal and overtime) worked per employee. (10)
1915.					*				
June 2 ...	32·9	77·9	19·0	—	—	3·3	3·2	6·4	61
1916.									
April 4 ...	30·1	—	15·8	—	—	4·6	7·1	11·4	55½
May 9 ...	29·4	75·3	16·9	—	—	3·7	3·4	6·9	57
„ 16 ...	33·1	75·2	17·4	—	—	2·5	4·9	7·3	59½
„ 23 ...	36·6	57·8	15·4	55·5	75·6	4·0	6·5	10·2	56½
„ 30 ...	33·5	69·6	16·9	68·5	72·9	5·3	5·2	10·3	57½
June 6 ...	33·6	58·6	15·2	57·2	73·2	4·2	6·1	10·1	56¾

On the other hand, in four light shops with about 200 employees, whose figures follow, the record for 1916 compares on the whole favourably with that for 1915. The sickness-rate is rather high throughout, but it shows a tendency to respond to the influences of improving weather and decreasing overtime, with the result that the average hours worked at the beginning of June, 1916, are nearly as many as in the heavy machine shops, though far more overtime was worked in the latter.

* In the earlier weeks of these records Sunday overtime, though worked, was not separately entered.

TABLE XIII.

Week ending (1)	Percentage ratio of normal hours worked on nightshift to total normal hours actually worked. (2)	Percentage of employees on overtime at all. (3)	Percentage ratio of hours worked overtime to practically possible normal hours. (4)	Percentage of employees working on Sunday. (5)	Percentage ratio of hours worked on Sunday to total hours worked overtime. (6)	Percentage ratio of hours lost by "bad timekeeping" to practically possible normal hours. (7)	Percentage ratio of hours lost by sickness to gross normal hours less leave. (8)	Percentage ratio of hours lost by "bad timekeeping" and sickness to gross normal hours less leave. (9)	Average hours (normal and overtime) worked per employee. (10)
1915.									
June 2 ...	35·3	84·6	23·5	—	—	3·5	6·6	9·9	60½
1916.									
April 4 ...	40·8	—	17·4	—	—	5·0	7·2	12·1	52¾
May 9 ...	34·9	65	15·8	—	—	2·9	7·3	10·0	57
„ 16 ...	35·5	66·8	16·7	—	—	2·8	6·0	8·7	57⅔
„ 23 ...	34·3	58·9	14·4	54·1	68·4	3·2	5·7	8·8	57
„ 30 ...	35·2	60·2	15·2	58·9	72·8	3·1	5·5	8·4	59⅓
June 6 ...	39·8	60·7	13·1	59·9	69·1	3·8	3·9	7·6	59½

(*c*) Sickness Before and Since the Outbreak of War.

34. Comparisons of figures of sickness before and since August, 1914, are hard to make, and of little value when made, because, even in factories which have not greatly expanded, the groups of employees would be constituted to a very great extent of different persons. Right at the beginning of the war a large proportion of the most vigorous and robust men left the factories, being reservists, territorials, and so on; many others volunteered; and only a small proportion (say 10 per cent.) of most necessary men had, last summer, returned from the Army to civil occupations. In one factory 42 per cent. of the men between 18 and 35 left at the outbreak of war; another had by July, 1916, lost over 800 out of the whole body of about 1,800 men, and recovered 85; another had lost over 180 out of 800, and recovered 20; and so on.

35. The loss of so many of the physically strongest men has meant their replacement by boys, women, older men, and physically inferior men. One firm writes, in a very carefully considered letter, that some of their men "had not done any regular work for years and are probably not physically fit for even a normal working week. One or two of them have been receiving parish relief, and one has been in the workhouse." Aged, decrepit men to whom charitable persons used to give occasional light jobs in a garden now form part of the regular body of employees in controlled establishments.

36. An increase in the sickness-rate is therefore to be expected, the newcomers being less robust and frequently unused to the noise and atmosphere and hustle of factory life. The increase has certainly occurred where and whilst very long hours have been worked, especially where work has been heavy in character. It has also occurred most conspicuously among officials and foremen. But where hours have been reasonable, and where, having been long, they have been reduced, it seems that, on the whole, sickness has been lower than in normal times, especially among those engaged in light work.

The figures of one large Trade Union show that the percentage of members on Sick Benefit in 1915 (after allowing for those serving in the forces) was lower than in any of the five preceding years; and though the number of members had greatly increased, and they were no doubt largely different persons, these changes merely reflect the changes which have taken place in factories and do not detract from the value of the evidence.

Similarly in a large factory in the Midlands, whilst the number of men coming under the State Insurance scheme had decreased by a sixth only, as between the spring months of 1914 and those of 1916, the amount paid in sick benefit decreased by a fourth; and under a voluntary scheme the amount paid decreased by over a fourth, though the membership had actually increased.

37. The explanation of this somewhat unexpected result lies in the fact that periods of good employment are periods of decreased invalidity. This law is excellently illustrated by the too little known curves of attendances at the Out-Patients' Department of the London Hospital, which the Superintendent (Mr. H. C. Barker, M.A., LL.B.) has kept for the last eight years, bringing them into relation with the general curve of unemployment published in the *Board of Trade Labour Gazette*, and with a special curve of unemployment in the London district so long as figures for the latter were available. I have to thank Mr. Barker for his kindness in allowing me to consult these valuable diagrams. From them it is apparent that, when allowance has been made for seasonal fluctuations, holidays on which the Department is closed, and other temporarily distracting influences, there is regularly an increase in the number of patients in the general medical department during protracted periods of unemployment, and a diminution of their number to a certain minimum as employment recovers. For instance, during 1908, when the percentage of unemployment rose from about 5½ to over 9, the monthly attendances rose from 5,000 to nearly 7,000; in 1909 unemployment fell gradually to about

6½ per cent., and the attendances to under 6,000; about midsummer, 1913, the figures had dropped after various fluctuations to 1·9 per cent. and 3,600; early in 1914 both curves rose again; and in 1915, as unemployment fell away to under 1 per cent., the attendances were once more reduced below 4,000, and have since remained remarkably steady at a minimum determined by other factors than employment. It is also noticeable in Mr. Barker's curves with what regularity the figures of attendances, unless already at this minimum, drop in each year during several weeks preceding Christmas, these weeks being a busy season in that part of London. The attendances of out-patients at a hospital are, of course, not directly comparable in all respects with the figures of sickness in factories, but they are in part affected by the same influences, and if good employment improves the health of the whole working-class district of East London, we should expect its effect to be still more apparent in factories themselves. What may cause surprise is that its effect has been so great as at least to counter-balance that of the withdrawal of a large proportion of the strongest and most healthy men from factories. But employment has been good, not only in the sense of being general, but also as being well-paid. The explanation therefore is partly that employees have been too busy to visit the doctor or to meditate on the state of their health, and partly that they have been more amply fed and with more nutritious food, more warmly clad, and (not least) more adequately shod; so that high wages, whilst they may (as is so often alleged) have produced some loss of time by way of slackness, have prevented a far greater loss by way of sickness. Not a little credit, too, is due in many places to the efforts of the Welfare Supervisors, especially among women, and to the provision of canteens where food may be obtained at reasonable prices.

III.—LOST "QUARTERS."

(*a*) General Remarks.

38. Work before breakfast is a topic closely connected with industrial sickness, for there is evidence, as will be seen below, that the abolition of early hours often results in an improvement of health. It is well-known that, when the dayshift is worked on the two-break system, a large proportion of time avoidably lost is commonly lost before breakfast. The following table illustrates this fact:—

TABLE XIV.

Class of Work.	Period.	Number of Employees considered (approximately).	Normal Dayshift Week.	Overtime.		Hours before Breakfast.	Percentage of practically possible Dayshift hours lost avoidably.	Percentage of such avoidable loss on Dayshift that is lost before breakfast.	Percentage of practically possible early hours lost.
				Amount.	When Worked.				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I. Light (females).	May/Oct., 1916.	900	Hours 53½	Considerable to end of July: little since.	Evenings	a.m. 6.20–8	—	—	7·3 (1)
II. Light...	May, 1916	1,400	53	Considerable	Evenings and Saturday.	6.45–8.30	2·7	35·0	4·9
III. „	May and Aug., 1916 (av.)	1,300	53	„	„	„	c. 3·0	45·3	7·9
IV. Medium	Aug., 1916	300	53	Moderate	Evenings	7–9	2·8	54·1	6·6
V. „	Year 1915/16	230	54	„	„	6–8.15	c. 3·3	c. 95·0	c. 12·7
VI. Mixed	Feb./May, 1916.	9,000	53	Heavy	Chiefly Sunday	6–8	14·0 (2)	20·0	c. 13·5
VII. Fairly heavy.	Year 1915/16	900	53	Moderate (fluctuating).	Chiefly evenings.	6–8	11·2	29·0	14·3 (1)
VIII. Heavy	Oct., 1916	120	53	Very heavy	Evenings and Saturday.	6–8	6·1	58·0	15·7
IX. Mixed	Aug./Oct., 1916.	130	53	Considerable	„	6–8	8·6 (3)	43·0	c. 17·0
X. Heavy	May, 1916	1,200	53	Very heavy	Evenings and Sunday.	6–8	5·9	57·0	14·6
XI. Very heavy.	„	200	53	Moderate	Evenings	6–8	9·0	53·0	21·0
XII. Very heavy.	„	250	53	Very heavy	Evenings and Sunday.	6–8	9·5	51·0	21·4
XIII. Heavy	May/June, 1916.	1,000	53	Moderate	Chiefly evenings.	6–8	5·6 (4)	35·9	c. 12·0
XIV. Very heavy.	„	400	53	Considerable	„	6–8	6·0 (4)	58·5	c. 18·5

(1) Percentage of practically possible "quarters" only; shorter periods not recorded.
(2) Percentage of *gross* normal dayshift hours lost for *any* reason.
(3) Percentage of *all* practically possible hours; no allowance for nightshift.
(4) Percentage of *gross* normal hours (day and night) lost for *any* reason.

In this table Nos. III., IV., V., and Nos. X., XI. and XII. together, refer to entire factories; in No. I. a comparatively few men are omitted, and in Nos. VI. and VII. a comparatively few women; Nos. II., VIII., IX., and XIII. and XIV. refer to some shops or departments only in large factories. All the factories are situated in populous areas except No V., which is in a small country town.

39. In *column* 9 the percentage of avoidable loss on dayshift that goes before breakfast is slightly understated for No. IX. where it has been impossible to distinguish dayshift hours from all practically possible hours; it is considerably understated for No. VII., since the firm's figures undoubtedly exaggerate the amount of avoidable loss by underestimating the amount of sickness, and do not record losses of less than a full "quarter"; and it is equally understated for Nos. VI., XIII. and XIV., where the loss in "quarters" is compared with total lost time and not with avoidable lost time only. The figures in this column, therefore, are rough, and probably rather too low throughout, despite the fact that sometimes employees coming a few minutes late are recorded as losing the full quarter-hour or half-hour which they are fined. Allowance made for under-estimation, it is clear that loss of early hours in all these ten factories constitutes at least 30 per cent. of the so-called "avoidable" loss on dayshifts, and probably more than 30 per cent. throughout, whilst sometimes the proportion is so high as to be the main determinant of the curve of bad timekeeping.

40. It must be borne in mind, however, that not all loss of early hours is really "avoidable." It often happens that a large number of the employees live at a distance from the factory, and any breakdown in transport may entail loss of time. As would be expected, it is often the most keen and sensible men who choose to live well away from their work, and on the whole they may lose less time than those who live near by; still, they are bound to lose quarter-hours and half-hours occasionally through no fault of their own, which go to swell the total loss in factories which fail to distinguish unavoidable lateness very carefully. At the present time, of course, factories which have greatly increased their numbers are often employing very many operatives, keen and slack alike, who cannot find lodging near their work.

41. Further, part of the loss of quarters is in some cases really due to fatigue and to minor ailments. The man who is "fagged" and "off-colour" after long hours of work, the man who has a heavy cold on a wintry morning, the man who suffers from rheumatism and has to start from home at 5 o'clock through the rain, may sometimes lose a quarter unnecessarily, but very often they save themselves from a more serious loss by occasionally "sleeping in." The officials of carefully-managed firms are generally well aware that not all "bad timekeeping" is morally bad, and in their minds make allowance for this fact; but in records, as a rule, the point is not made apparent.

42. *Column* 10 of the same table, giving the percentage of practically possible early hours lost, refers only to loss of quarters or shorter periods as such, and does not include the loss of a quarter involved in the loss of a half-day or day; in factories No. I. and No. VII. only full quarters are accounted, the loss of shorter periods not being recorded. In Nos. VI., XIII. and XIV. a conjectural allowance has been made for sickness, &c., in arriving at the percentage, so as to make the figures comparable with the rest, but they are to be taken as approximate only.

43. It will be noticed that the loss of possible early hours is much less in the factories which start after 6 a.m. than in those which start at that hour, and this appears to be the general rule, though of course there are exceptions. In only one case do I happen to have obtained figures from a factory starting work at 6 o'clock where the percentage of possible quarters lost was low, and those figures were not sufficiently accurate to be included in the above table. The factory was engaged on heavy work, with considerable overtime but little nightshift. In May last roughly about 3·6 per cent. of practically possible dayshift hours were lost avoidably; of this loss 41·5 per cent. occurred before breakfast, but as the quarter was 2½ hours, this means a loss of only about 5·3 per cent. of possible quarters. In March the loss had been much heavier, and altogether these figures seem to be exceptional rather than typical.

44. Officials are often inclined to surmise that if their rules about late entry were stricter, when they are easy, or more lax, when they are strict, attendance would improve. The arguments for and against either course are obvious: the tendency during the war has been towards a relaxation of rules, especially when a large number of the employees live at a distance. In point of fact, however, there does not seem to be any normal relation between degrees of punctuality and degrees of strictness or laxity in rules. On the whole experience seems to favour rather strict rules combined with a reasonable willingness to make exceptions in case of transport breakdown or other unavoidable accident; but in large factories this is difficult to arrange, and even in small factories strict rules are not always successful. *E.g.*, No. V. above refers to a small factory, most of whose employees live near by; the rule is that after 6 a.m. up to 6.15 a man is counted as having lost half an hour, and after 6.15 cannot enter till 9; most of the men are time-workers, and in addition to losing their time-rate, latecomers are (by arrangement between the firm and employees) fined for the benefit of the men's sick club; and yet the percentage of time lost before breakfast is high, practically all the avoidably lost time going in the early hours.

45. In some of the factories whose results are tabulated above the proportion of lost quarters is higher than in normal times, and this for four principal reasons:—

First, employees have been taken on who are unused to factory life, and some of whom are too unstable either physically or morally or in both respects to work full hours.

Secondly, dearth of men, especially in some skilled heavy trades, compels employers to tolerate irregularity which would be punished by dismissal in time of peace.

Thirdly, the present darkness of the streets on winter mornings militates in some places against punctuality.

46. The first and second reasons apply to lost time generally, but especially to lost quarters, and against them must be set regularity above the normal on the part of the best and keenest employees. The effect of overtime on lost quarters is difficult to determine at all precisely. The

different ways in which overtime may cause loss of normal time have already been mentioned; here the only question is how far it *necessitates* lost quarters by overstrain. Evidently, if a person by "sleeping in" occasionally prevents a breakdown in health which would mean a much longer absence, the loss of a quarter now and then may be entered as bad timekeeping, but is really commendable.

47. Now in some cases where heavy overtime is worked the lost quarters are partly attributable in this way to fatigue and reasonable prudence. Thus, *e.g.*, the men in heavy machine shops recorded in Table XI., whose overtime hours in May were over a fifth of their practically possible normal hours, and whose average loss of such normal hours by bad timekeeping in that month was only 1·6 per cent. (or a little over three-quarters of an hour a man), made on an average 71 per cent. of that loss before breakfast (or about 36 minutes a man). There is no doubt in the case of these amazingly steady workers that the bulk of this loss (which = 5 per cent. of possible early hours) is really unavoidable. As was pointed out on p. 6, the same is probably true of a proportion of the quarters lost by the whole body of employees recorded in Table II. At the same time it cannot be argued that overtime accounts for the majority of lost quarters. If it did, we should find (1) reduction of overtime constantly accompanied by a drop in the number of latecomers, and we should probably also find (2) some relation between the days on which overtime is worked and the days on which most quarters are lost. Frequently, however, no such connections can be traced. Thus—

(1) In the factory whose figures are given under No. I. in Table XIV., the women were up to the end of July working 2¾ hours overtime on three or four evenings each week. (The normal dayshift ended at 5.30; they had then, when on overtime, ¼ hour for tea, which was provided free, and worked on from 5.45 to 8.30). It might have been expected that cessation of overtime would have reduced the number of quarters lost, especially as over 50 per cent. of the girls live at a distance, with very poor transport facilities; as a matter of fact, however, the attendance in the morning decreased in August, and showed no improvement even in September after a holiday. Again, the men recorded in No. XI. of the same table, working moderate overtime, lost many more quarters than those in No. X., and nearly as many as those in No. XII., both working very heavy overtime.

(2) The days on which quarters are principally lost bear no relation to those on which overtime is worked. Monday is universally the worst day; as a rule the morning after the day to which pay is accounted is next to it in loss of quarters. The day-to-day curve of lost quarters is sometimes remarkable for the regularity of its movements. In Diagram V. the absolute figures, which are high, are replaced by letters. Pay in the factory referred to is accounted to Tuesday; Monday is the worst day, Wednesday comes next to it, and Saturday (being a short shift) is the best. The curve has had this form for years past; this extract from it refers to four weeks in May and June, 1916.

One curious result of this selection of days is that a holiday on Monday is apt to lower, and a holiday on Saturday to raise, the weekly percentage of time lost avoidably: Monday is from this point of view the most economical full day for a holiday.

48. The regularity with which a greater number of quarters is lost on certain days indicates deliberate choice of those days, and the preference for "sleeping in" on Monday, even when there has been no Sunday shift, disproves any direct connection between overtime and much of the loss of early hours. It is, of course, true that a man who feels "fagged" or "off colour" may to some extent choose his peaceful mornings with other considerations in view besides his need of rest, but if definite fatigue were the main motive, the tendency would be for most absences to occur in the second part of the week among men not engaged in work on Sunday. Another negative argument is the heavy loss of quarters on the day after a general holiday. The true motive, there, as on Mondays, is the drag of the flesh against beginning the same old grind again.

(*b*) One-Break and Two-Break Systems.*

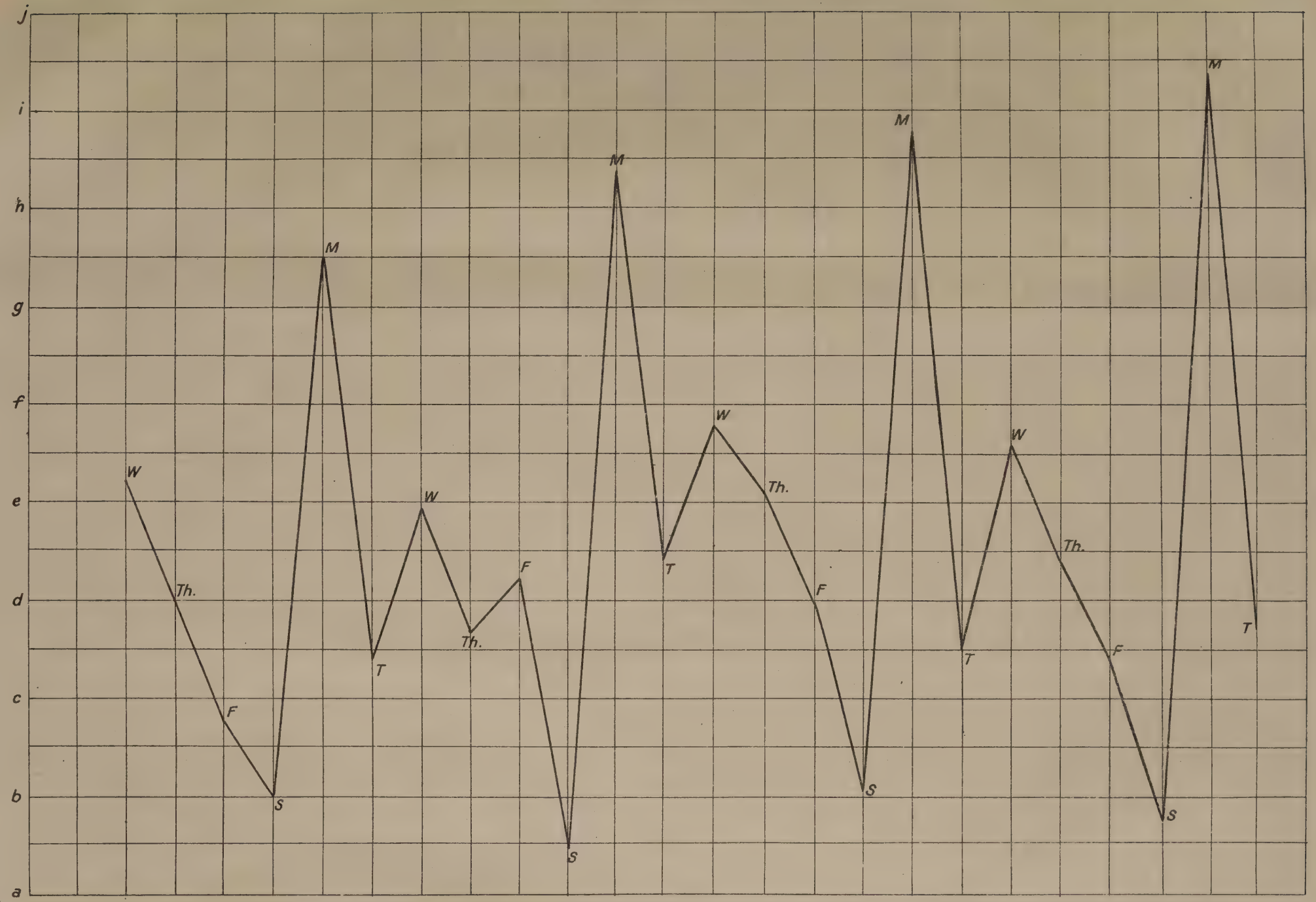
49. Seeing that in the factories quoted in Table XIV. the best results are obtained when work is started later than 6 a.m., the further question suggests itself whether the two-break system would not be better abolished. The mere number of absences, whether avoidable or not, is by itself a serious matter. It involves considerable disorganisation; sometimes a nightshift man has to be kept at a machine on overtime rates when he ought to be in bed; sometimes a man has to be brought from other work to a vacant machine; frequently the supply of material to a further stage in manufacture is retarded.

50. But this is only part of the objection to the system. It is only a minority of persons that can put out their best work before having a proper meal in the morning. One manager observed that when he was in the shops he had calculated his own output and found that, even when he was equally keen and interested, it was only about a third in the early hours of what it was after breakfast. In heavy works this point may be obscured, and men will sometimes argue for early hours on the ground that their best work is done then. But, of course, the comparison must be between the first few hours of work when begun before breakfast and the first hours when begun after breakfast, not between the first couple and the second couple of hours on the same day.

51. A third objection to the two-break system is that every break means some waste of time before and after. Attention is apt to be diverted from the work in hand to the food's condition some time before the interval, and after the interval a shop generally takes a little time to get into full swing again. This waste of time may indeed be diminished by the provision of a breakfast canteen or by very efficient arrangements for warming the breakfasts, but power-records are apt

* As hereafter used, the term "one-break system" means starting work after breakfast, and the term "two-break system" means starting before breakfast. The terms have no reference to what may be the optimum number of subsequent breaks.

DIAGRAM V.



5979.

Malby & Sons Lith.

to show a gradual drop in the half-hour before breakfast and again a gradual rise in the half-hour after it. Fourthly, the much later entry of the superior officials has a bad moral effect upon the operatives. Fifthly, in the absence of superior officials the foremen's supervision is often lax. Lastly, lost quarters are apt to lead to lost days, as is shown by the figures of Firm D below.

(i) *Details of Factories.*

In view of these objections a certain number of firms have in recent years gone over from the two-break to the one-break system, whilst there are others that have throughout worked on the latter system, as, indeed, has long been done in some factories, especially those controlled by Sir William Mather and Sir Robert Hadfield. The following notes concerning some such firms contain figures which may be compared with those in previous tables.

Firm A.—Light work (textile).—Two factories in the same town. Under the old system work began at 6 a.m. and the first break was at 9 o'clock; piece-workers worked 55 and time-workers 55½ hours a week, the odd half hour being used for cleaning up. Some years ago hours were reduced to 49 and 49½ a week, with shifts as follows:—

Monday to Friday, 8-12.30, 1.30-6.
Saturday, 8-12.

There is no nightshift.

In the first factory the following records compare the absenteeism among about 3,700 female workers for the six months ending in August of the year before and the year after the change.

	Before the change.	After the change.
Average number of hours lost each week overhead for any reason ...	3·77	2·54
Percentage of gross possible hours lost for any reason	6·84	5·16
Percentage of employees absent one *morning* a week	10·93 (for 3 hours).	2·51 (for 4½ hours).

The improvement in respect of morning attendances was most marked among the piece-workers; before the change they lost on an average more mornings than the time-workers, but after the change fewer, though their total percentage of time lost continued to be higher than that of the time-workers.

In the second factory (somewhat larger, but more accessible), a comparison of three corresponding months before the change and in 1915 (some years later) shows:—

	Before the change.	1915.
Average number of hours lost each week overhead for any reason ...	2·66	1·85
Percentage of gross possible hours lost for any reason	4·8	3·8
Percentage of employees absent *at all* for any reason	18·0	7·6

The change of system did not involve any loss to time-workers; piece-workers' earnings on an average improved all round, owing to their more regular attendance and greater vigour; health has improved; work is better both in quality and quantity; and the total output has increased, despite the reduction of hours which, although the attendance has improved, has considerably lowered the average number of hours worked. No separate record of sickness is kept, but the management considers that most of the time now lost is due to sickness, though sometimes of a minor kind.

Before the change was first introduced, a ballot of the workers was taken (in a January) to ascertain whether the 8 o'clock start was preferred for the winter months; 77·4 per cent. of the workers voted in favour of it. In the May following a further ballot was taken, to determine whether the change should be permanent; 62·84 per cent. of the workers voted in favour of it. The reduction of the majority was probably due to several causes. First, in the summer months the early start was less disliked. Secondly, the *immediate* effect of the change had been some diminution of output and decrease of piece-workers' average earnings. Thirdly, when reduced hours are said to bring in the end an increase in average piece-workers' earnings, it must be remembered that the strongest and deftest workers, who had made most under the old system, may earn rather less than before.* The management after some years' experience of the change is extremely well satisfied with it, and considers that, were a ballot taken now, not 10 per cent of the employees would vote for reversion to the old system.

Firm B.—Engineers: work of medium heaviness. Factory in a small town, with fair train service and good tram service to larger towns (3 miles or more away) where some of the employees live. A few years ago the weekly dayshift hours were reduced from 54 to 50, with shifts as follows:—

Monday to Friday, 8-12.30, 1.30-6.
Saturday, 7-12.

---

* *Cp.* the Report of the Chief Inspector of Factories, 1913, p. 60, on reduction of hours with 8 o'clock start in linen-weaving sheds at Dunfermline. Hours were reduced 15 per cent., piece-rates raised 5 per cent. The best piece-workers' earnings (though not the average) were reduced about 10 per cent.

There is little or no night work. Exceptions to the change are the iron foundry, which is on two shifts, and another very hot shop, which is on three 8-hour shifts; but these two shops are small. Total employees, from 600 to 700, nearly all males.

Time-workers received the same actual wages as before the change; piece-workers soon came to earn as much as, or more than, before. Output, after the first few weeks, showed no decrease, but, if anything, an increase.

Men are not allowed to bring breakfast with them, and the rules of late entry are very strict. Any one at all late runs the risk of losing the whole day. The works manager makes a point of being in the factory by 8 o'clock, so that he requires no more of the men than of himself—a point to which he attaches great importance. Loss of time, except through sickness, has practically ceased altogether; and sickness itself has shown a marked decrease. Neither management nor men would on any account revert to the old system.

It is worth noting that overtime, when necessary, is worked in the early morning. The extra pay induces regular attendance, and the most highly paid work is done when men are fresh, and not when they are fagged. Moreover it was found after experiment that early overtime is a healthier arrangement, especially in the summer, than extra hours at night.

Firm C.—Engineers: factory in a small town; work fairly heavy; an unusually high proportion of skilled men. Number of employees over 1,000, at the time of the change of system all males, mostly living reasonably near the factory. Until a few years ago a 53 hours dayshift week was worked, starting at 6 a.m. A change was then made to the one-break system with the following hours:—

Dayshift.—Monday, 7.30-5.30.
Tuesday to Thursday, 7-5.30. } with an hour off for dinner.
Friday, 7-5
Saturday, 7-11.30.
A 51 hours week.

Nightshift, 7-10, 11-7, when necessary.

The rules about late entry are now very strict. Before the change there had been quite unusual slackness, even foremen missing quarters, and the amount of time lost by bad timekeeping only (apart from sickness) was as much as 16 per cent. of possible hours. Moreover, power-records showed much waste of time just before and after the breakfast interval. The result of the change was to reduce the loss by bad timekeeping to 2·5 per cent. No doubt this striking improvement is not wholly due to the change itself, but partly to stricter supervision, and to the dismissal of very slack foremen by a new and very energetic managing director. The latter himself, however, is very strongly in favour of the new system, and considers the hours particularly good. It will be noticed that an allowance is made for the difficulty men feel in getting out of bed on Monday morning, and that the strain is eased off towards the end of the week.

In order to meet the objection that under the one-break system the spells of continuous work are too long, a travelling tray goes round at about 10.15 a.m. on dayshift and 2 a.m. on nightshift bearing biscuits, mineral waters and (at night) tea, and so on, which men may buy and consume for quarter of an hour in the firm's time without leaving their machines.

Firm D.—Engineers: factory situated in a small town in a very populous industrial district, employing about 900 males, with a comparatively small number of women and girls. Work mostly heavy. No regular nightshift; overtime moderate. Employees mostly live fairly near the works.

The two-break system was worked until the middle of March, 1916. Under that system the hours were as follows.—

Monday, 9-1, 2-5.
Tuesday to Thursday, 6-8.30, 9-1, 2-5.
Friday, 6-8.30, 9-1, 2-6.
Saturday, 6-8.30, 9-12;

making a week of 51½ hours. The dayshift week of the district is 54 hours, but the Monday "quarter" had been abandoned as hopeless.

The loss of quarters had long been a serious trouble. At one time men missing quarters were fined sixpence, the fines going into a central fund which was periodically distributed in proportion to the hours men had worked; but this device was not very successful, and being also unpopular was in the end abandoned. Towards the end of 1915 the firm suggested a change to the one-break system, the hours to be 8-1, 2-6 on Mondays to Fridays, and 8-1 on Saturdays. Various objections were raised by the men, of which the chief was that a clash with school-hours would prevent their children from bringing their dinner to the works. It was agreed to continue the old system for a month on trial, with slight modifications, but the result was unsatisfactory, and finally the change was made last March, with the strong approval of the Ministry of Munitions. To meet the objection mentioned, the spells are arranged as follows:—

Monday to Friday, 8-12.30, 1.30-6.
Saturday, 8-1,

an arrangement which has the further advantage of avoiding a 5 hours spell except on Saturday. It has been agreed that the change shall be in the first place for the period of the war only, and that at the end of the war a reversion shall be made to the old system, if employees so desire.

Under the new system the rules about late entry are strict. No law is allowed, but foremen are instructed to accept reasonable excuses. The dayshift week having been reduced to 50 hours, a man working the full time gets 4 hours bonus, *i.e.*, is rated as having worked the 54 hours of the district. But before going on to overtime rates he must actually work 54 hours (rated as 58). Overtime work is partly carried on in the morning—from 6 to 7.30 a.m., steady men being selected for that period.

This example of the change of system is important as having been effected during the war. Some doubt may be felt whether such a change must not, even though advantageous in the long run, result in reduced output for a time. The firm's experience shews that such a reduction need not always take place; output increased immediately after the change, and the improvement has been maintained ever since.

The effect upon time-keeping is illustrated by the following figures:—

Under the two-break system the hours avoidably lost in days and quarters were in January, 1916, over 5 per cent. of gross possible normal time, and in March over 7 per cent. Under the one-break system the avoidable loss was in July 0·8 per cent. and in November 1·5 per cent. Thus whilst the nominal weekly hours had decreased as between February and November from 51½ to 50, the average hours actually worked (unavoidable absences apart) increased from under 48 to 49¼. Exact figures of unavoidable absences are not forthcoming, but the firm is certain that sickness has also decreased.

Before the change over 40 per cent. of the total avoidable loss went in quarters. But the following figures also confirm the opinion which is often expressed that lost quarters bring lost days with them,

1915.	Percentage of quarters lost avoidably.	Percentage of days lost avoidably.	
January	8·3	Over 3·2	Two-break system.
February	12·1	Over 4·3	
July	—	0·8	One-break system.
November	—	1·5	

Even under the new system Monday remains the worst day for absences. In July there were on an average twice as many men away on Mondays as on the other days, and in November over four times as many; indeed, the increase in loss of time in November over July is almost entirely due to absentees on Mondays. But the general improvement in attendance is very remarkable.

Firm E.—Engineers: factory situated in a large town; about 1,050 males and 350 females employed. Work varies from light to fairly heavy. Until June last a 53 hours dayshift week was worked with daily hours as follows:—

Monday to Friday, 6.30-8.30, 9-1, 2-5.30.
Saturday, 6.30-8.30, 9-12.30.

A change was then made to a 50 hour week, with the following daily hours:—

Monday to Friday, 7-12, 1-6.

The nightshift is small, but when needed works from 7 p.m. to 6 a.m. with a one hour break. It is not usually necessary for dayshift and nightshift to meet.

The new dayshift hours involve two five-hour spells, but the workers are allowed to have a drink of tea and some food between 8.45 and 9 a.m. on the understanding that the work proceeds at the same time, and in the afternoon a boy is told off to prepare a can of tea for any workers who wish it on the same condition. Moreover, the men in the foundry, which is large, are allowed some latitude in going home before closing hour, if their work is done. A point of special interest is the abolition of normal work on Saturday. At present most of the men are working overtime from 7 to 11 a.m. on Saturday, receiving pay at the rate of time and a quarter; but in normal times, when there is no pressure, they will have Saturday free. The firm considers that this scheme has two great advantages: when overtime is necessary, it is worked when the men are comparatively fresh, and when it is unnecessary, the two days' rest at the end of the week will give them time to pursue their private interests and will be beneficial to their health.

It will be noticed that this change also has been introduced during the war. A few objections were raised at first, chiefly on the ground that the new dinner-hour differed from that usual in the district, but the firm considers that the men are now all in favour of the five-day week. Most of them are time-workers, and they receive the same amount of wages for 50 hours now as for 53 hours previously. Output probably fell for two or three weeks immediately after the change, but is now greater than before, time-keeping having improved remarkably. The avoidable loss of time in the spring before the change was sometimes as much as 10 per cent. of possible normal time; in December, 1916, it had dropped to 2½ per cent. Health has also improved. Rules about late entry are now strict, the right of late entry at 7.30, which was at first allowed, having led to irregularity. Monthly certificates, which carry a cash bonus, are issued to those who keep perfect time, and a further annual bonus is proposed.

The following notes refer to firms which have never worked on the two-break system:—

Firm F.—Engineers: work light, but in large part highly skilled. Over 1,500 employees, including now about 10 per cent. women.

Dayshift week, 50 hours, with shifts as follows:—
Monday to Friday, 8-12.45, 1.30-6.
Saturday, 8-11.45.

From 11 to 11.20 a.m. and 4 to 4.20 p.m. men are allowed to smoke at their work, smoking in lavatories, &c., having been prohibited. Power-records show a slight decline at these times, but on the whole the result is regarded as beneficial. Women get a break of 10 minutes or so. The nightshift is comparatively small. Overtime is worked in the evening. The firm would have preferred overtime on Saturday, as the normal Saturday shift is too short to be very useful; but after a trial the men objected.

Rules about late entry permit considerable latitude, allowing 5 minutes' grace in the forenoon and 2 minutes in the afternoon, after which men lose by quarter hours, coming in when they will. Records of lost time, taken occasionally, are very regular, and show that the total loss is, according to the season, from 2·5 to 3·5 of possible ordinary hours, *i.e.*, the average ordinary hours worked vary from 48¼ to 48¾. Notified sickness accounts for 0·5 to 1·0 per cent. of possible time, *i.e.*, for quarter to half an hour in every working week, but the managing director regards a great part of the remaining lost time as being due to minor ailments. He considers that the late start combined with great cleanliness in the factory and excellent dining arrangements have a very beneficial effect on the health and vigour of the men, with the result that the quality and quantity of the work done are superior to those usual under the ordinary arrangement of hours. He was, however, inclined to think 6 p.m. a trifle late for stopping work, and to think the Saturday shift rather too short.

Firm G.—Engineers: factory in a small town, employing over 2,200 males and over 600 females; weight of work very much varied.

Dayshift.—Monday, 7.30-12.15, 1.15-5.45.
Tuesday to Friday, 7.15-12.15, 1.15-5.45.
Saturday, 7.15-12,
i.e., a week of 52 hours.

The nightshift is comparatively small, and works from 5.45 to 10, from 11 to 3.30, and from 4 to 7.15, all hours over 52 in the week ranking as overtime. (Recently a change has been made in two-shift shops, lengthening the dayshift hours by overtime, and reducing the nightshift.) Munition workers on shells, &c., are on the special schedule shifts. About half the employees were working overtime in July, 1916, averaging 9 hours each.

Rules about late entry are fairly strict, and after 7.45 employees cannot go in without special permission till dinner-time. To encourage punctuality comparative returns are posted of the percentages of employees in different shops losing half-hours in the morning. A note is added calling attention to the importance of regularity, and appealing to the employees' patriotism. In most departments the number of late arrivals is from 2 to 5 per cent. in good weather, and from 3 to 8 per cent. in bad.

In the period of 13 months to the end of July, 1916, the proportion of possible time lost for any reason, if broken holiday weeks and the week of the blizzard at the end of March are excluded, was just over 7 per cent. This is not a specially low figure, but its height is mainly due to unusually bad transport facilities: about 15 per cent. of the employees live in villages up to 6 miles away, and they are largely dependent on bicycles for getting to their work. Bad weather has therefore a trebly evil effect on timekeeping, discouraging some from leaving home, making others late, and causing illness in others. The figures for the early summer of 1916 are distinctly better than those for 1914, before the war. The management of the firm emphatically prefers the one-break system, and believes it to be preferred by employees also. But a rather later start would probably improve timekeeping and health in this factory.

Firm H.—Engineers: a very large factory on the outskirts of a large town; work very various in weight, and comparable with Firm G's.

Dayshift.—Monday to Friday, 7-12, 1-5.30.
Saturday, 7-12,
a 52½ hours week.

Nightshift.—8-12, 1-6, a 45 hours week. The shifts are connected by overtime, where necessary.

Rules about late entry are easy, time being lost by quarter hours up to 9 a.m., after which there is no admission before dinner. Some girls are on three shifts, and their record is the worst in the factory; generally, there is no material difference from pre-War figures, though the presence of a considerable proportion of less efficient men may have increased slightly the percentage of time lost. At the end of July, 1916, this was 6·4 per cent. of gross possible time (about 3·4 hours overhead) lost for any reason whatever. It had been considerably lower, but the hot weather raised the figure. The proportion accountable to sickness and other unavoidable reasons is not separately recorded, but as 15·7 per cent. of the employees lost

6 hours or more each, it is probably considerable; and this view is supported by the more detailed figures for one department quoted in Table III. There the percentage of possible time lost for any reason was 7·9 at the end of July, and of this about 61 per cent. among the males and 79 per cent. among the females (72 per cent. overhead) was unavoidable, the percentage of practically possible time avoidably lost being 2·5 among males, 2·0 among females, and 2·2 overhead. In that department, during the weeks whose figures are tabulated, an average of 57·5 per cent. of the males and 63·7 per cent. of the females (60·6 per cent. of all employees) lost no time at all each week.*

Firm I.—Engineers: three factories, Nos. 1 and 2 in proximity to one another in a large town, No. 3 in a small town in the same district.

Factory No. 1 (of which some shops are recorded as No. II. in Table XIV.) employed in the spring something under 7,000 men and about 400 women on light work, a comparatively small proportion being skilled. Factory No. 2 (the No. III. of Table XIV.) employed from 1,300 to 1,500 men, with a higher proportion skilled. Factory No. 3 employed under 1,500 operatives, also on light work, and a small number of women.

Factories Nos. 1 and 2 work the following dayshift hours:—
Monday to Thursday, 6.45-8.30, 9-1, 2-6.
Friday, 6.45-8.30, 9-1, 2-5.30.
Saturday, 6.45-8.30, 9-12.

In Factory No. 3 the dayshift hours are:—
Monday to Thursday, 8-1, 2-7.
Friday, 8-1, 2-6.
Saturday, 8-12.

The dayshift week is, therefore, 53 hours in all three factories.

In February, 1916, a comparison of the records of the men only in the three factories gave the following results:—

TABLE XV.

Factory.	System.	Percentage of Men losing avoidably				Hours Lost.					
						Avoidably.		Through sickness or leave.		Total.	
		Under 5 hours a week.	5 hours but under 10.	10 hours or more.	Any time at all.	Per employee (hours).	Per cent. of possible normal hours.	Per employee (hours).	Per cent. of possible normal hours.	Per employee (hours).	Per cent. of possible normal hours
No. 1	2-break	23·9	5·5	6·6	36·1	1·692	3·2	1·237	2·3	2·929	5·5
No. 2	2-break	22·3	2·8	5·7	30·9	1·458	2·7	1·197	2·2	2·655	5·0
No. 3	1-break	0·4	0·5	0·06	1·0	0·060	0·1	1·197	2·2	1·257	2·38

In the middle of March Factory No. 1 showed an avoidable loss of 1·17 hours (2·2 per cent.) per male employee and 1·79 hours (3·3 per cent.) per female; whilst in Factory No. 3 the male employees lost avoidably 0·066 hours (0·1 per cent.) and the 170 female employees no time at all, the average loss overhead being 0·058 hours (0·1 per cent.).

Timekeeping is good in all three factories, none of which starts work very early, but uncommonly good in the third. One might be inclined to attribute its superiority to local conditions, or to the fact that a larger proportion of employees were on overtime in the other works, were it not that a few years ago Factory No. 1 had the same arrangement of shifts that Factory No. 3 now has, and the total lost time recorded for a period under the one-break system was only 1·670 hours overhead (or 3·1 per cent.). The average loss by sickness in February, 1916, is much the same in all three factories, viz., about 1·2 hours. This is not a high figure—in Factory No. 1 it had mounted a fortnight later to 3·15 hours for males (7·23 for females)—and we may fairly deduct 1 hour from the 1911 record on this score. That leaves an avoidable loss of 0·6 hours per employee under the one-break system, as against 1·69 hours in February and 1·17 in March, 1916, under the two-break system. Examples of a reversion from

* In regard to bad timekeeping generally, a record of the percentage of employees losing time avoidably is a useful check upon the percentage of time avoidably lost. Thus in the week ending May 23rd, 1916, the employees referred to in Table II lost 4% of practically possible time, but 48% of them lost no time and another 25% lost less than 4%. In the same week the men recorded in Table VII lost nearly 10% of practically possible hours, but of them 53·5% were losing not more than 2 hours, and another 23% not more than 4 hours, showing that the high loss was mainly due to a few men. In a subsequent week in September, the distribution of loss was more general, but even then 40% of the men accounted for 75% of the time lost. Again, in the factory referred to as No. VII in Table XIV, whilst the avoidable loss for a period of 61 weeks was recorded as 11·2% of gross possible time, over 65% of the men are recorded as losing not more than 2 hours in each week, or in other words as being reasonably good timekeepers.

the one-break to the older system are very rare; in this case the step was taken for reasons irrelevant to this discussion, and the results scarcely give cause for satisfaction. The records of this firm are specially interesting because the difference in early hours is not complicated by a difference in the number of hours worked a week, whereas in all the other instances quoted of the one-break system the total hours are shorter than is usual under the two-break system.

(ii) *Results of the Evidence.*

53. It appears—

(1) that if early hours be worked, the loss is likely to decrease if the start be later than 6 a.m.;

(2) that when the total dayshift week is the same, there are likely to be more hours actually worked without than with work before breakfast, other conditions being similar;

(3) that a reduction of hours may be compensated for or even outweighed by the abolition of early hours, partly owing to reduced absences, partly owing to reduced waste of time, and partly owing to the greater vigour of work after food.

These conclusions need some amplification and qualification.

(1) Early work in factories seems to be an inheritance partly from the necessary habits of agriculture and partly from the urban habits of a period when towns were small and unlit at night, and the population went early to bed. The modern industrial town does not begin to be interesting or stimulating, or even to veil its ugliness, until the lamps are lit. It is vain for employers to recall the customs of their forefathers (whom after all they do not emulate), and to bewail the degeneracy of these latter days. The village can rise early because it goes early to bed. But the town dweller will not go early to bed, which would mean for him having no life of his own.

The first and simplest way of meeting the difficulty is by starting a little later and ending a little later. Even to do so on Mondays only (or to abolish the early hours on Mondays only) is a gain of time; but a somewhat later start throughout is better, because it assists those employees who live at a distance and gives all more chance of taking some food before leaving home.

On the other hand this plan does not avoid the inferiority of work before a regular meal or the disadvantages of two breaks, and it presents this difficulty, that if a full two hours be worked before breakfast, the meal is put still later than on the usual system, whilst a shorter spell is in some classes of work too short to be effective. Of course, if timekeeping alone is considered, the shorter the spell, the better.

(2) It is rarely that a direct comparison is possible, such as that between the factories of Firm I above. Differences in management, kind of work, local customs and character, amount of overtime, accessibility of the factory, and so on, are so numerous and important that comparative figures should, as a rule, be regarded as at most indicating a tendency, not as establishing a law. The opinions of experienced managers and other officials, acquainted with both systems, are really more valuable than any number of figures, and I have found such opinions unanimously against the two-break system, in consideration alike of effective organisation, timekeeping, health, and output.

(3) A discussion of reduction of normal factory hours after the war is outside the scope of this memorandum; I have found among managers and employers a frequent (though not unanimous) opinion in favour of it, coupled with considerable difference of opinion as to the best mode of effecting it. Anyhow, where abolition of work before breakfast has been accompanied by a reduction of hours, the result has been all to the good in the factories mentioned. When loss of quarters and wasted time about the breakfast interval are at all considerable, a reduction in hours may mean a gain in time worked, if early hours are abolished. Suppose 100 men on a normal dayshift week of 53 hours, losing "avoidably" 10 per cent. of possible quarters, and suppose that each man present wastes 2½ minutes before the breakfast interval and 2½ minutes after it, the time lost or wasted in these ways is 165 hours in all. Suppose that after a change to the one-break system 15 per cent. of the men lose half-an-hour each day, or 45 hours a week, there will be a gain of over an hour a man each week, or in other words the dayshift week can be reduced by an hour with no loss in time actually worked.

The example is artificial, of course. It takes no account of sickness or of avoidably lost days; but the evidence is that both decrease on the one-break system. It supposes that before the change loss in the early hours goes entirely in whole quarters, which is never the case; but the waste of time is as bad or worse if men trickle in gradually. It certainly under-estimates the amount of wasted time that is frequently found about the interval,* and does not put the case for the one-break system in an unfairly favourable light. The gain in time may easily be greater, and, as has been pointed out, time is only part of the gain.

54. In this connection the following table has some interest, showing the average number of normal dayshift hours actually worked in certain factories. It must be read subject to the warning already given against hasty comparisons and generalisations, and allowances must be made for the different times of year, but, that understood, it does appear to indicate that, as the nominal hours are reduced, the hours actually worked do not fall in proportion. In this table all normal time lost is allowed for, whether due to slackness or to sickness and other unavoidable

* *Cp.* Dr. Vernon, *supra*, paragraphs 29 and 30.

causes. (The average total hours, normal and overtime, differ, of course, more widely than the average normal hours only, the highest total total averages being those of Nos. 8 and 13).

TABLE XVI.

Class of work.	System.	Period.	Number of hours before breakfast in week.	Time of start on dayshift.	Normal dayshift week.	Average normal hours actually worked on dayshift.
					Hours.	
1. Light (textile)	One-break	3 months, 1915	—	8 a.m.	49	47·2
2. „	„	Spring, 1916 ...	—	8 a.m.	50	48·5
3. Mixed	„	Year, 1915–16	—	7.30 a.m., Monday 7.15 a.m., Tu.–Sat.	52	48·1
4. „	„	July, 1916 ...	—	7 a.m.	52½	49·1
5. Light	„	February, 1916	—	8 a.m.	53	51·7
6. „	Two-break	„ „	10½	6.45 a.m. ...	53	50·4
7. „	„	„ „	10½	6.45 a.m. ...	53	50·1
7. „	„	March, 1916 ...	10½	6.45 a.m. ...	53	48·7
7. „ (some departments).	„	May, 1916 ...	10½	6.45 a.m. ...	53	50·1
8. Light	„	Autumn, 1915	12½	9 a.m., Monday ... 6 a.m., Tu.–Sat....	53	49·4
9. Medium ...	„	Apr.–Aug., 1916	12	7 a.m.	53	50·5
10. „ ...	„	Year, 1915–16	13½	6 a.m.	54	50·0
11. Fairly heavy ...	„	„ ...	12	6 a.m.	53	46·2
12. Heavy	„	May–June, 1916	12	6 a.m.	53	50·1
13. „	„	„ „	12	6 a.m.	53	48·3
14. „	„	May, 1916 ...	15	6 a.m.	53	49·4
15. „	„	March, 1916 ...	12	6 a.m.	53	44·3

55. That, sickness apart, the 53 or 54 hours weekly dayshift represents an ideal which is often scarcely expected to be attained may be seen from the details of arrangements for a good time-keeping bonus. One manager of great experience and insight told me that in his opinion a man on heavy work who does not lose more than three hours (a "quarter" and two half-hours) in the week should be reckoned a good timekeeper, which comes to much the same thing as saying that 50 hours is a fair week. Under another scheme two hours are allowed to be lost avoidably before the bonus is forfeited; under another, where the work is lighter, two half-hours are allowed and a "quarter" occasionally; and in yet another case, whilst the full bonus is paid only if no time be avoidably lost, five-sixths of it is paid when two hours are lost, and two-thirds of it when four hours are lost.

But, however strong the arguments may be in favour of shorter hours of work, the question of doing away with the early quarter is in principle independent of them, and particularly it ought not to be confounded, as it has often been, with the question of a 48 hours week.

(iii) *Some Objections Considered.*

56. It appears to be a fairly common experience that proposals for abolishing early work are not liked beforehand by employees, and occasionally employers who contemplated the change have given way to the objections expressed. Some of these objections are peculiar to the details of particular schemes. If the proposal is to reduce hours, time-workers naturally object unless their earnings remain as before; and it is only fair that they should not be losers if they are expected to maintain the same output by working harder. Piece-workers, too, are apt to under-estimate their power of increased production under the better and healthier conditions, and, as has been mentioned, the *best* piece-workers are likely to lose a little (even though the majority rather gain) unless their rates are raised. On the other hand, if hours are not shortened, employees fear over-long spells, and sometimes not unjustly, unless the spells be eased by a travelling canteen, a period when smoking is allowed, or short pauses occasionally. Moreover, when hours are long and work is hard, the early spell does provide the good workman who is a trifle off-colour with an economical means of saving himself from over-strain; if it be abolished and hours remain equally long, and if rules about late entry are strict, he may have to lose a half-day where previously he lost a quarter. This objection, though not very frequently advanced, is important, and, whilst it does not outweigh the opposed difficulty that the short spell before breakfast is a standing temptation to slackness, it deserves sympathetic consideration. It may be met partly by pointing out that to start work after instead of before food by itself diminishes strain, and partly by giving foremen or other officials power to grant leave for an occasional hour or two in the morning to those who genuinely need the rest.

57. But the most general ground of objection is domestic. At present the man is often out house before his wife gets up. If he has sense and time, he makes himself a cup of tea on a cold morning before starting and takes a cup up to her; when he is gone, she gets up, makes the children's breakfast, and sends them off to school. The man's own breakfast, which he takes

with him, has been prepared overnight. Under the one-break system, men fear, an additional burden will be put on their wives, who must rise earlier because they themselves rise later. The sentiment is laudable, but the anticipated difficulty does not as a rule come to anything in point of fact. When hours are shortened and work begins at about 8 a.m., there is obviously little or no ground for complaint, and it is clearly to the good that men should have one more meal with their families. Even when work begins at 7 a.m., the difficulty seems not to materialise: thus when Firm C. made the change, much trouble was prophesied, but it came to nothing. In that case, however, the men lived fairly near the factory, and clearly there may be a real difficulty when a large number of men live, say, an hour away. When this is so, it may be doubted whether work should start so early as 7 a.m.; but if it must, the difficulty may be met by providing a mess-room where men can buy breakfast. Mess-rooms with kitchens are increasing and will, it is hoped, become permanent institutions; and where dinner is cooked, breakfast presents no insuperable difficulty.

58. A remarkable example of prejudice (for it is little more) among employees in favour of early hours is to be found in the town where Firm D's works are situate. In that town are a number of other factories engaged on work of a different character from Firm D's—hot work in part, but not heavy. They employ a large number of females as well as males, the latter doing most of the hottest work. One of these factories is managed on the one-break system, and there little time is lost. The remainder work 2½ hours daily before breakfast, with a dayshift week of 54 hours, and timekeeping in them is bad. In one of them, for example, where over 500 operatives are employed, 21·8 per cent. of possible quarters were avoidably lost in November. In another, employing about 150 males and 100 females, the figures were still worse. During the first six months of 1916 the men and boys appear to have lost over 20 per cent., and the women and girls nearly 50 per cent. of possible quarters, the loss of time before breakfast in some weeks amounting to over 10 per cent. of normal dayshift hours. The total loss, especially among the women and girls, continues high. Thus, in a week of July, the male employees lost for every reason 10·6 per cent. of normal hours, most of the loss occurring before breakfast; in a week of October they lost 9·1 per cent. (6·1 per cent. avoidably); and in a week of December 9·5 per cent. (5·5 per cent. avoidably). In the same weeks the women and girls lost 20·9 per cent., 23·6 per cent. (16·4 per cent. avoidably), and 20·8 per cent. (17 per cent. avoidably). In the factory last-mentioned, the figures of unavoidable absence may have been under-estimated, and the conditions of work are partly responsible for the bad time-keeping; but, however, that may be, the desirability of adopting the one-break system in this whole group of factories is patent. In the two factories that have adopted it in the town (Firm D's and another), the results have been entirely satisfactory, the avoidable loss being about 1½ per cent. of gross normal time. The remaining employers wish to copy their example, starting work at 8 o'clock and reducing hours from 54 to 50. Time-workers would not lose, and all but a small minority of the piece-workers miss so many hours at present that they could without difficulty maintain or even increase their output in the shorter week. Yet, whether from mere vague suspicion, or from unreasoning conservatism, or because the advantages have not been lucidly explained to them, the employees, and especially the men, have objected so strongly to the proposed alteration of hours (principally on domestic grounds) that up to the present, after months of negotiation, it has not been carried through. The fact seems to be that most of the objections usually raised by employees in anticipation against the change of system are rooted in custom and in a general suspicion of any proposal, the results of which they do not precisely foresee. Hence it follows that the more employees are alert, well-informed, and well-educated, and the more their employers have in the past studied their comfort and won their confidence, by so much the more easily is the change effected.

(*c*). Conclusion.

59. *The case for doing away with early quarters is strong in respect of factories engaged on light or moderately heavy work, with no nightshift or a comparatively small one, and especially where women and girls are employed.* Of the disadvantages already mentioned as arising from working before breakfast, the most serious, perhaps—though all are serious—are the inferiority of hungry work, its bad effect upon health, and the temptation to lose time owing to the shortness of the early spell. In my opinion, it is safe to conclude that *work before breakfast ought not to be instituted in any factories answering to the above description which are newly opened during the further course of the war;* and the evidence also shows that even during time of war it may under some circumstances be advantageously abolished in old-established factories. As a rival to the two-break system with an early quarter, the one-break system at present holds the field, and usually hours are shorter under this system. But to what extent hours may be reduced without diminution of output, at what hour exactly it is best to start work, whether in some kinds of work a new break later in the day might not involve less waste of time than a breakfast-break commonly does and be in other respects desirable—these and similar questions, though some of them have been incidentally discussed above, depend for their answer on a number of varying local conditions, require further accumulation of experience, and are in any case secondary to the main contentions that *food should precede work,* and that *the first spell of work should be of such a length that employees do not miss it light-heartedly.*

60. The range of applicability of the above conclusions has been carefully limited, because in heavy works where there are a number of continuous processes, or where generally a large proportion—a third or even in some shops a half—of the men are on nightshift, the fact that dayshift and nightshift must meet raises serious difficulties. It makes impossible any genuine

shortening of the daily* dayshift hours, for it is out of the question to increase the nightshift hours, which are as a rule in heavy works already fully long enough. No doubt the nightshift might start later and end later—say at 7 a.m. But it is very doubtful whether in really heavy work a five-hour spell, from 7 a.m. to noon, would be good for the men or profitable to the firm.

Moreover, it must be admitted that, at any rate in summer, the cool of the early morning is very suitable to some kinds of heavy and hot work, if only better attendance could be secured, though the importance of this point has been diminished by the Daylight Saving scheme. The solution of the difficulty may be an extension of the three-shift system in heavy works. Such a solution is not applicable at present, owing to the dearth of skilled men in many trades and the difficulty of increasing the number of foremen and of staff generally. But it has the advantages of shortening hours, of giving men respite from early rising, and at the same time of keeping the plant running; and in heavy works with big machines, where the ratio of plant-cost to wage-cost is exceptionally high, this last advantage is of great importance. The three-shift system for women does not appear to have been universally successful. It seems likely, however, that its lack of success has been due to conditions which affect women rather than men—*e.g.*, to the women on the third shift objecting to go long distances at night through darkened streets, and to a frequent tendency of women to over-tire themselves with house-work during their periods of rest. Moreover, the great majority of the women are new to factory life, and no conclusion can be drawn from their experiences as to the effect of the three-shift system on men in established industries. A study is desirable of the results of that system where it is now working, not merely in shell-shops and the like, but also and specially in factories engaged upon heavy work which corresponds fairly closely to their normal work in time of peace.

IV.—SUMMARY OF PRINCIPAL CONCLUSIONS.

61.—(1) There is pressing need for an improvement in the form and credit of medical certificates. (Pars. 15–18.)

(2) The proportion of lost time that is due to sickness and other unavoidable causes is, as a rule, greatly under-estimated in factories' records, and the proportion due to slackness consequently over-estimated. (Pars. 20–25.)

(3) The accuracy of sickness-records may be tested by asking—

(*a*) Do the curves of bad timekeeping and sickness coincide in direction?

(*b*) Is the number of whole weeks lost through sickness abnormally high when compared with the number of shorter periods similarly lost?

(*c*) Is the number of days lost through sickness abnormally high when compared with the number of quarters similarly lost?

An affirmative answer to any of these questions, unless explicable otherwise, gives good reason for supposing the rate of sickness to be understated. (Pars. 20–32.)

(4) Long hours, much overtime, and especially Sunday labour, have a pernicious effect upon health, particularly in heavy trades. (Pars. 20, 21, 33 (5).)

(5) Except where hours have been very long relatively to the class of work, sickness does not appear to have increased in factories generally since the war, despite the withdrawal of many of the most robust men; and the absence of such increase is to be ascribed to good employment and high wages. (Pars. 34–37.)

(6) Work before breakfast gives inferior output, lowers health, and leads to great loss of time as the first short spell is so frequently missed. Experience shows that in certain descriptions of work the early quarter has been advantageously abolished both prior to and even during the course of the war, and under similar conditions it ought not to be instituted in new factories opened during the further course of the war. (Pars. 38–59.)

December, 1916.

THOMAS LOVEDAY.

---

* The *weekly* dayshift hours are another matter. A Director of a firm to which I have been specially indebted in this study told me that, in his opinion, after the present stress is over, the abolition of Saturday work (except, of course, as regards continuous processes, maintenance, &c.) might be desirable, especially as giving married men two consecutive days at home. But that suggestion belongs to the larger question of reduced hours in general. *Cp.*, however, Firm E's experiment above-mentioned.

INCENTIVES TO WORK, WITH SPECIAL REFERENCE TO WAGES,

with an

APPENDIX ON WAGE SYSTEMS.

CONTENTS.

INCENTIVES TO WORK, WITH SPECIAL REFERENCE TO WAGES.

1. The rate of output, which is frequently, even for individuals, a measurable quantity, may be an indication of the presence or absence of fatigue; and the occurrence of sickness, as indicated by irregular timekeeping, and of injuries, may be some measure of the health and efficiency of operatives; but of all the varied influences affecting the health and efficiency of munition workers, the Committee have found that of *incentives to work* the most intricate and difficult to investigate. Nevertheless, the subject is of such immediate importance as to demand consideration.

2. The inclination to work rather than to be idle, even though this inclination is a variable quantity in different individuals, is an important natural phenomenon, as important as the desire for rest which follows work at periodical intervals. Various incentives, such as the necessity to earn a daily livelihood, may reinforce this inclination, and some incentives are operative to-day which are peculiar to the present crisis, such as a patriotic desire to contribute to the defence of the realm, or a wish to avenge a lost relative. When once industrial life has been entered upon, the ordered and systematic routine of a modern factory is a direct stimulus during every 24 hours to the rhythm of activity and rest; the better the organisation, and the better the hygienic environment, the greater is the stimulus to activity, and the worse the organisation and environment the sooner comes the desire for rest.

3. Whatever the original motive to undertake munition work may have been, the vast majority of operatives so employed to-day earn their living thereby; and the stimulus systematically used as a reward for work done and to procure even greater activity is payment of wages. Any discussion of

wages from the standpoint of political economy would be foreign to the scope of the Committee's deliberations, though they recognise that considerations of the greatest moment must, on this ground, be excluded from the present study; but they have constantly found that the health, *i.e.*, the absence of sickness, physical and mental, and efficiency of workers is influenced by their earnings, and that output, which has been closely investigated as an indication of fatigue, may be influenced by the wage system in force. They have, therefore, considered it desirable to state how far they have found the efficiency of workers affected by the method of remuneration adopted. Other influences may arise to stimulate the inclination for work, pride in craftsmanship and in work well done, personal rivalry to outstrip a fellow worker, or hope of promotion; but the main incentive for consideration is that of wages.

The absence of incentives may be presumed to lead to neutrality, while the operation of some factors may result in actual repression of the normal working activity. Among these latter the Committee would attach particular importance to any circumstances which may bring the operatives to the opinion that they are not being " fairly treated."

4. The problem of the present moment in munition factories is how best to obtain a practically unlimited supply of munitions of war, of such articles as artillery, shells, and cartridges, all of which are required in great numbers and of fixed sizes and patterns. Herein, because constant repetition work gives the best opportunity of standardising means of production and of organising labour, the problem is somewhat different from, and so far simpler than, that of most industrial productions which must be varied to meet the fluctuations of popular demand, and is largely influenced by the question of economic production and profits. The problem has been further simplified by the guarantee that when once a scale of pay has been fixed there shall be no " cut " in prices, a constant source of fear amongst operatives in the past.

METHODS OF REMUNERATION.

5. Wages may be paid either—

(i) for the time during which work is done, that is by the hour, the day, or the night;
(ii) for the work done, that is by the piece; or as a minimum sum up to the completion of a certain task beyond which piece rates are paid.

(i) Payment by Time.

6. Certain work, however sub-divided and specialised the processes of manufacture become, cannot be paid for by the piece, and such work, roughly speaking, lies at the two extremes of labour, the most highly skilled and the least skilled. Managers, foremen, craftsmen, skilled fitters and pattern makers are instances of the former class, and general labourers about the yard, shop cleaners, and watchmen are instances of the latter.

Among the highly skilled workers who are paid comparatively high wages commensurate with their skill, but little further incentive should be called for except that supplied by patriotism, and the pleasure and pride in their craft for its own sake. Certainly for this class of worker any fear of dismissal is to-day small, since the supply of skilled workers is below the demand.

Among the least skilled workers time wages act as an inducement to work, because their daily bread depends thereon, but they hold out no inducement to special endeavour. Supervision by foremen, inevitably associated with more or less friction, may be required to obtain increased effort from a proportion of workers paid by this method. Fines may be found necessary to prevent bad timekeeping, or rewards or bonuses may be offered for good timekeeping, but good timekeeping does not always mean good work.

Payment by time possesses one advantage over payment by piece in that it removes from the operative an element of uncertainty concerning his earnings; an uncertainty which, especially in the case of juvenile and female labour may create a nervous anxiety detrimental to sustained effort. Combination of time wages with piece rates has been used as a method of obtaining this advantage in connection with piece rates.

Generally speaking, payment by time alone, which is unavoidable for a large proportion of work, has no direct influence in stimulating the inclination to work; and under this system some workers may be expected to keep well within their powers, while others, whose inclination to work is greater, may feel it a grievance that extra exertion brings with it no extra return.

The good results, however, which are attained from payment by time indicate that, given suitable environment, the inclination to work is a deep-seated natural phenomenon; and it is questionable whether in the end the best results may not be obtainable by following the principle of a " good day's work for a good day's pay," with reasonable good faith on the part of both employers and workers.

(ii) Payment by Work Done.

7. The desire to bring a direct stimulus to bear on the natural inclination to work has led to the introduction of payment by work done, or piece rates; and the manufacture of munitions of war, which is so largely constant repetition work applied to a great number of minutely sub-divided processes, lends itself particularly to this form of payment.

The problem is to determine how wages can be arranged so as to provide the maximum incentive to production without so tiring the operatives that they are unable to maintain the pace over long periods, or that an ever-increasing number of " stragglers " (who might have developed into useful workers) are constantly dropping out by the way.

Many forms of piece rates have been devised and are in use in this country; and the principles underlying them are discussed in an appendix.

8. *Comparison of Time Wages and Piece Rates.*—Although good output can undoubtedly be obtained by the system of time wages, and the unfavourable environment often found in industrial concerns should, perhaps, share the blame for some of the poor results which advocates of piece rates have instanced, yet under suitable conditions, particularly for monotonous repetitive work, increased output can be secured by well arranged piece rates. One instance is sufficient to demonstrate the incentive value of such rates; and in the following table (obtained by Mr. P. S. Florence while investigating for the Committee) the daily output of the same groups of girls is compared for two consecutive weeks, for the first of which time wages were paid, and for the second progressive piece rates.

Day of the week.	June 12th—16th. Time-wage.		June 19th—23rd. Piece-wage.	
	17 girls drilling fuzes.		17 girls drilling fuzes.	
	Day Shift.	Night Shift.	Day Shift.	Night Shift.
Monday...	2,266	...	2,567	3,050
Tuesday	2,050	2,094	2,959	3,242
Wednesday	2,037	1,552	3,143	3,255
Thursday	2,610	2,537	3,066	3,114
Friday	3,188	2,394	3,291	2,171
Average output per shift	2,430	2,144	3,005	2,966
Percentage increase ...	...	...	24	40

Day of the week.	Three girls retapping fuzes by hand.		Three girls retapping fuzes by hand.	
	Day shift.	Night shift.	Day shift.	Night shift.
Monday...	1,997	1,414	3,040	2,388
Tuesday	1,351	1,684	1,534	2,046
Wednesday	1,260	1,375	2,180	1,584
Thursday	2,023	1,691	2,520	2,592
Friday	2,139	1,636	1,955	2,900
Average output per shift	1,754	1,560	2,246	2,302
Percentage increase ...	...	...	28	48

9. *Need for Explaining Piece Rates.*—Whatever system of piece rates is adopted, there can be no doubt that, if it is to influence output, it must be clearly understood by the operatives; that is to say, any operative of average intelligence must be able readily to compute how much extra pay he will earn at any stage for extra output. The Committee have found that sufficient attention is not paid to this question, and that workers frequently complain, either that they do not know how they are paid, or that they are simply content to trust their employers to pay more for greater output. Thus Captain Agnew, after investigating the health and conditions of employment of a large number of male workers, reports in reference to wages that—

> " Mistrust, discontent and misunderstanding are frequent among employees, who imagine that they are being exploited, when, as not infrequently happens, they are unable to estimate for themselves their exact earnings. When wages are paid by the ton or by the piece the method is clearly understood; but when payment is made by some decimal of a total output unknown to the workers, by a share of a sum allotted to a large group of workers, or by a varying piece rate with a bonus added, the calculation is either impossible or too complicated for the wage earner, and suspicion as to its exactness is prevalent, at least among adults—indeed, the wages department itself often seems doubtful about the exactness of the methods."

10. A definite example may be given of restriction of output, which was reported to the Committee by Mr. P. S. Florence, as coming under his observation while carrying out an investigation with the object of discovering whether the efficiency of certain workers was on the upward or downward

grade over a relatively long period of overtime and night work, and attributed by him to failure on the part of the operatives to understand the system of wages in use. He reports:—

"Certain girls were chosen at random in an 18 lb. shell case department (where the work of each individual was of sufficiently uniform nature); and the average output per hour of each of them was found to be as follows:—

Process.	No. of Worker.	Date of Starting Work.	Average hourly output for one week in the middle of			
			Sept. 1915.	Nov. 1915.	Dec. 1915.	Jan. 1916.
Plugging mouths ...	1	June, 1915 ...	157	163	202	214
	2	June, 1915 ...	150	201	173	194
	3	July, 1915 ...	167	193	197	190
Washing and drying	4	June, 1915 ...	51	63	58	64
	5	June, 1915 ...	58	54	61	65
	6	June, 1915 ...	58	49	61	70
	7	June, 1915 ...	48	62	60	72
Head turning ...	8	Dec., 1914 ...	28	25	26	29
	9	June, 1915 ...	25	25	25	27
	10	Jan., 1914 ...	25	25	25	25
	11	Jan., 1915 ...	25	25	25	25
	12	May, 1915 ...	25	25	25	25
	13	July, 1915 ...	25	25	24	25
Finish under heads...	14	Jan., 1915 ...	38	38	38	38
	15	May, 1915 ...	38	38	38	38
	16	Sept., 1915 ...	38	38	38	38
Finish boring and screwing primer holes	17	June, 1915 ...	25	25	25	25
	18	July, 1915 ...	25	25	25	25
	19	July, 1915 ...	25	25	25	25
	20	Aug. 1916 ...	25	25	25	25
	21	Sept., 1915 ...	25	25	25	25
	22	Sept., 1915 ...	25	25	25	25
	23	Oct., 1915 ...	...	25	25	25
Boring mouths ...	24	July, 1915 ...	70	70	70	62
	25	June, 1915 ...	70	70	70	70
	26	Aug., 1915 ...	70	70	70	70
Rough boring primer holes	27	Aug., 1915 ...	33·2	34·0	34·0	34·2
	28	Aug., 1915 ...	34·0	34·0	34·2	33·8
	29	Aug., 1915 ...	34·3	34·5	34·4	34·4
Cutting to lengths ...	30	Sept., 1915 ...	100	100	100	100
	31	Sept., 1915 ...	100	100	100	100
	32	Sept., 1915 ...	100	100	100	100

"The striking feature of the above table is the extraordinary stability of output of individual girls, and the still more extraordinary similarity in output of different girls employed at the same process; and for the process of finish boring and screwing, and of 'head turning,' the recurrence of 25 as the rate per hour for four different weeks seems almost to attach a mystical significance to that figure; and the same thing applies to the output of 38 for the process of 'finish under heads,' of 70 for 'boring mouths,' of 34 for 'rough boring primer holes,' and of 100 for 'cutting to lengths.' Further inquiry, however, elicited that the wage system (which was what is known as the premium bonus scheme) was not understood by the wage earners; and that the foremen, unable to make it intelligible, indicated a standard of output which would satisfy the firm. Independent evidence that this standard was well within the capacity of the workers, and that they made no effort to exceed it was obtained by a study of the amount of electrical power used in driving the machines from hour to hour, which was recorded in curves by self-registering meters. These curves showed a deep and continuous fall in the power in each of the workshops concerned in the last two hours of the day and night shifts; from which the conclusion may be drawn that most of the girls completed their standard of output about two hours before the end of the shift and then went 'easy.' Since other girls who started work at the same factory in June or July, 1915, but who were employed on processes for which no such standard was indicated (workers numbered 1 to 7 in the table) attained an output in January, 1916, at least half as much again as their output of September, 1915, the firm seems to have lost considerably by the failure of the management to make their wage system intelligible to the workers."

11. A special clause of the Factory Acts (S. 116, Factory and Workshop Act, 1901) deals with wages—a clause which is of great value to piece-workers. This applied first of all to spinning and weaving

only, but has by degrees been extended to a great variety of other industries. It provides that, when workers are paid by the piece, particulars in writing shall be furnished to each worker respecting the rate of pay and the work to be done so as to enable the worker to compute the total amount payable to him. The particulars necessary for this purpose vary according to the method of calculating the wage and the nature of the work to be done; and great care has been taken in framing orders for the different industries to safeguard the worker from a mere perfunctory compliance which may rob him of the benefit it is the aim of the clause to secure—that benefit being the possession of data sufficient to enable him to compute the total amount payable and to feel confident that effort to secure increased pay by increased work will not be frustrated by fraud or negligence on the part of the employer or any of his agents. A study of the various Orders made under the Act since 1901 will show that there has been a progressive effort to make the giving of these particulars more precise in order that they may leave the worker in no uncertainty. But various as are the trades included, there is no Order which covers munition factories—an Order was in draft intended to apply to all engineering trades, and the draft with a covering letter had been sent to employers, but on the outbreak of war it was not proceeded with.

12. *Need for Study of Wages Earned.*—The example given in the previous section shows the value to managers of watching closely the wages earned by individual workers. Normally, if all is going well, the output (of which the wages paid to individuals are a direct indication), while varying somewhat from week to week, should show a steady increase, rising rapidly, with new workers, and more and more slowly as they became more and more efficient; any deviation from this rule should call for immediate investigation.

The following data provided by Dr. Vernon give concrete instances of this rule:—

Newly engaged Workers.

Process.	Number of operatives.	Relative hourly output during								
		1st week.	2nd week.	3rd week.	4th week.	5th week.	6th week.	7th week.	8th week.	9th week.
Turning fuze bodies	16 women ...	*67*	*91*	96	96	96	100	99	101	100
Making cartridge cases { second draw ...	12 women ...	*70*	*81*	*91*	96	97	99	99	100	102
Making cartridge cases { second cut-off ...	14 women ...	*71*	*79*	*87*	*89*	*94*	99	100	98	102
Making cartridge cases { mouth reamering ...	16 girls	*48*	*64*	*67*	*79*	*78*	*89*	*89*	99	101

In this table the average output during the last four weeks (or two weeks in the reamering process) is taken as 100. The operatives engaged at turning fuze bodies nearly attained their full output in three weeks, but those at the simpler cartridge operations took longer, whilst the girls engaged at mouth reamering, an operation involving more quickness and dexterity than the others, did not reach their full output till the eighth week. In certain shell operations, such as "boring the powder chamber" and "finishing, turning and forming," Dr. Vernon found that men took three or four months to attain their full output.

Workers of some Experience.

Process.	Number of operatives.	Relative hourly output during			
		six weeks.	next five weeks.	next six weeks.	next five weeks.
Various cartridge case operations {	112 experienced women ...	98·5	99·4	99·8	102·4
Various cartridge case operations {	146 less experienced women	95·4	97·2	103·1	104·6

In this table the output of both sets of operatives shows a steady increase, but that for the "less experienced" increased about twice as much as that for the others.

13. If the output of individuals maintains a dead level, as in the instance previously quoted, something must be wrong, and probably with the incentive. If the output is declining something must also be wrong, and probably with the conditions of employment; the hours of work may be too long; the conditions under which the work is done may be unfavourable, *e.g.*, bad ventilation, inadequate lighting, lack of canteen facilities; or fatigue may be arising from long journeys to and from the factory, or from imperfect housing accommodation. The Committee desire to lay special stress on the importance, and indeed the necessity, of constant study of this valuable source of information, which is in the possession of every firm, but which their investigations have found to be commonly neglected.

SOME INSTANCES OF THE FAILURE OF WAGE SYSTEMS TO ACT AS INCENTIVES.

14. *Lack of desire to earn more.*—Piece rates have been introduced primarily to increase output by acting as a direct incentive to the wage-earner to earn more wages; incidentally, they tend to relieve friction between workers and foremen. But in order to act as an incentive, the presumption is made that wage-earners always desire to earn more wages. While this is undoubtedly true in the main, instances have come to light where this presumption does not hold good. Thus, a report upon an investigation into lost time made by Professor Loveday for the Committee at a factory where a substantial bonus is paid for good timekeeping, and where timekeeping in most departments is good, states:—

> "The record for another set of workers is very different. They have consistently lost far more time by bad timekeeping than by sickness, and even though the proportion is not so bad this year (1916) as last, in recent weeks they have lost under this heading about 9 per cent. of practically possible time. This record is far from good, especially as their overtime has not been heavy and has included very little Sunday labour.
>
> "This criticism does not, however, apply to the whole body of men concerned; over half of them were keeping good time, and another quarter were keeping fairly good time; the remainder, less than one-fourth of the whole, were responsible for about seven-tenths of the total time lost by bad timekeeping.
>
> "The causes of this inferior record are probably social and economic. These special workers have been earning high wages, which have risen relatively more than those paid to other workers in the industry, and they include a large proportion of men unable to make a satisfactory use of high wages.
>
> "The employers, faced by a shortage of labour, have had to take on and keep on men whom in normal times they would not tolerate (nearly 60 per cent. of the men have been engaged since the outbreak of the war). Apparently the unusually high wages have led some of the men to neglect the possibility of earning the bonus for good timekeeping. It does not follow that lower wages and less demand for their services would improve their attendance. A rapid cure is probably impossible; but in the long run better education, bringing a higher standard of comfort, might be a more desirable remedy than a long and hungry waiting list."

15. Similarly, Captain Agnew, in reference to boy workers, reports that the rapid rise in wages from pre-war time to those of the present day is such that the average youth does not much concern himself with the amount of his output or with punctual timekeeping, for he feels confident that, whatever he does, on pay day he will receive more than he requires for his immediate needs.

16. Evidence on this matter has also been laid before the Committee by employers of labour, who declared that in certain classes of men the more they earn the less work they do. The instinct for saving being undeveloped, they naturally require leisure time in which to spend earnings above the subsistence margin. In other words, they are receiving a wage higher than is necessary for the maintenance of their normal "standard of comfort." This raises fundamental economic issues of far-reaching importance, and time, education and experience can alone secure a happy and effective adjustment. One expressed the view that, as a result of the high wages (£5 to £10 or even more per week) earned to-day by piece workers in his district, many of whom were previously unskilled men, a number of them are inclined to irregularity of attendance because they can easily make up their wages to an amount sufficient to cover their needs. A second witness further pointed out that the skilled workers, upon whom the efficiency of the whole work depends, paid a day rate from £3 to £3 10s. per week, suffer in contrast under an anomaly which is having a serious mental effect, prejudicial to good attendance.

In contrast may be instanced a factory where the environment of labour as regards supervision of the welfare of the workers, the hygienic conditions of the workshops, the means of transit and the housing accommodation of the district were all far above the usual standard of industrial centres, and where the rate of wages paid was distinctly low, as compared with that ruling to-day in more characteristically industrial areas. A medical examination, carried out by Captain Agnew of a random, but sufficient, sample of the operatives established that their health, physique and alertness were well above the usual standard; and it was ascertained that the firm were entirely satisfied with the regularity of attendance and with the rapidity and quality of output obtained.

These examples are sufficient to show how intimately the wages question is bound up with social, economic and hygienic considerations.

17. *Lack of Opportunity to Spend.*—A further point in relation to the incentive value of wages is that wages are only of value for what they buy, and that the mere possession of money is useless unless there is something to spend it on, and an opportunity of so spending it. The inducement to save, even when suitable opportunities of investing (a form of spending) are provided, is never so powerful as the inducement to spend.

Anyone familiar with the industrial classes knows the rise of output which occurs before a public holiday with the prospect of ample opportunity of spending. (*See* Table 1, page 18). This point to-day is not negligible when, in the hope of obtaining increased output, work has been frequently carried on during Saturday afternoon, the time most used for spending by the industrial classes. If employers take up the whole of their operatives' time in the factory, they should not be surprised to find that even the best devised wage scheme fails to act as an incentive, especially among juvenile wage-earners, who form a large proportion of the operatives employed on piece wages. From this point of view, even picture palaces have their value.

18. *Lack of Adjustment of Wage Systems.*—Another instance, which the work of Mr. S. Florence brought to the attention of the Committee, may be given of the failure of a piece-rate scheme to act as an incentive owing to a failure of adjustment of wage systems. Previous to the war two systems of payment were in use (1) a minimum sum, a time wage instituted to pay beginners, which was given for all work, however small, up to a certain amount, and (2) after that limit a plain piece rate for further work. When, however, the minimum sum to be paid was raised under war prices, the limit of work to be done for this sum was raised, and it became difficult to reach an output on the piece-rate scale.

> " When a full time wage is guaranteed, however low the output, it is obviously short-sighted thus to set a piece wage which on the average will not amount to much more than this guaranteed wage. If girls know that they cannot exceed by very much an output of, say, 9,000 lb., for which they get 17s. piece wage, they will be content to produce, say, 8,000 lb., and still receive 17s. in this case as a time wage. The result amply confirmed this expectation. It was well nigh impossible for the girls to earn piece wages in excess of the guaranteed time wage. Consequently they did not try, and the majority even of the more efficient girls were found to be working, in fact, not on a piece wage but on a time wage. The loss in incentive, and incidentally in discipline, must have been measurable in tens of thousands of cartridges per month."

19. The scheme of paying a minimum sum as a time wage for all output below a certain standard (always presuming this standard is fixed well within the powers of the workers), and piece rates for work done in excess of that standard, commends itself to the Committee as a useful method for removing mental strain from a worker who on account of feeling fagged may be over-anxious as to her capacity for earning a bare livelihood. Such a worker, with this strain removed, may end by producing a full week's work; with it present, an injudicious effort may result in an unnecessary breakdown. And the Committee have noted with satisfaction that in the First Schedule of the Munitions Order No. 1, dated 13th September, 1916, it is laid down that " the appropriate time rate shall in the case of any woman or girl on piece work or premium bonus system be guaranteed and paid." Another method also used for obtaining the same end is the fellowship system, where the operatives work in groups, and are individually paid a share of the total earnings of the group; where friendship exists among the members of each group this method is productive of excellent results, but complaints are liable to arise that one or another member of the group is not contributing a fair share to the common stock, when inquiries and adjustments may have to be made. Further, this fellowship system seems to defeat its end when applied to large groups of workers, amounting in some cases to several thousands; here the wages of each worker depend to so slight extent on individual effort that there is practically no incentive whatever in the system.

20. *Piece Rates may cause Over-speeding.*—The next point for consideration is the possible influence of piece rates in stimulating the operatives to over-work; an influence more likely to affect the better and keener class of workers who are to-day of special importance. Such workers require in their own interests to be protected against their eagerness. Again and again investigators have reported to the Committee that the data at their disposal for examining output over sufficiently long periods are curtailed by the disappearance of a certain proportion of the operatives.

Thus Dr. Vernon, reporting on the output of lathe operators at a munition factory, states:—

> " The strongest women available were picked out for the work, but many of them could not stand it for more than a few weeks. Of the 95 operatives of whose history I possess an adequate record, 22 gave up after four weeks or less, and 11 more after 10 weeks or less, but I have no information as to the cause of their retirement."

The Committee have also ascertained in reference to a munition factory employing between seven and eight thousand males under the age of 21 years, that every three months 25 per cent. of this total disappear.

Captain Greenwood further reports that at another factory, out of one group of 287 girls at work in the week ending 24th January, 1916, 30 had disappeared by 3rd April, a period of 11 weeks; out of another group of 77, 14 had disappeared in the same period; out of another group of 37, 12 had disappeared; and out of another 100, 16.

Since " the whole of the operatives providing the data were, so far as could be ascertained, strict piece workers, who had, prior to the periods studied, sufficient experience to have attained their normal level of productive power," even after due allowance has been made for the nomadic habits of workers, the Committee consider that such figures indicate a serious and undue wastage of skilled labour. Steps are being taken to investigate more fully the extent and causation of this wastage.

SUMMARY.

21. The preceding sections suggest that certain definite influences are important when arranging incentives intended to stimulate the natural inclination to work.

1. A healthy environment in the factory and in the home is the first necessity in order to obtain a healthy population of wage earners to whom a wage scheme may appeal as an incentive to work.

2. Under conditions of repetition work, especially if it be monotonous, piece rates may be expected to give a greater output than time wages.

3. The rise and fall of wages (paid on a well-planned piece rate) earned by individual workers is a valuable indication of health and efficiency.

4. A wage scheme, the operation of which cannot be easily understood by the wage earners, or, if understood, appears to them inequitable, fails as an incentive.

5. A wage scheme which is badly adjusted may lead directly to limitation of output.

6. A scale of wages which renders it possible for the wage earners to obtain too easily all the money which their social aspirations demand fails to provide an adequate incentive.

7. Hours of labour, which give but little chance of spending the wages earned, diminish the incentive to earn more money.

8. Workers, especially those newly introduced to industrial life, require protection against their own eagerness.

FURTHER CONSIDERATIONS.

22. *Necessity for Rest Pauses.*—No wage system known to the Committee takes any special account of the physiological fact that the natural inclination to work is followed by a desire for rest. Incentives, used to stimulate the inclination to work, must lose their effect as this inclination gives way to the desire to rest; and what is required is not to increase or diminish the incentive but to maintain the inclination to work. In previous memoranda (*see* pages 10 and 25) attention has been drawn to the advantage of rest pauses during long spells of work; and a further example has come under observation which indicates the natural tendency of workers under favourable conditions to alternate work with rest:—A group of workers, men and women, paid on a time wage, were found employed from 6 a.m. to 6 p.m. with two half-hour meal intervals at the process of emptying and filling a series of presses. Each press, after being filled, has to be left under hydraulic pressure for 35 minutes, during which time other presses in the series are emptied and filled. The management calculated the number of presses to each series, which would allow the work to be done in 35 minutes at a reasonable pace; but the workers on their own initiative have adopted a different method. They work with a rapidity so organised that the series of presses is emptied and filled in less than 25 minutes, after which they rest for 10 or 12 minutes until the time comes to begin again. The work entails the expenditure of a fair amount of physical energy; and it was interesting to watch these operatives swing into their labour in order to obtain their rest pause.

As an extreme instance, what has now become a classic case may be referred to:—*Mr. F. Taylor found good, average pig iron handlers, loading pigs of iron, weighing about 92 pounds each, into railway wagons at an average pace of 12½ long tons per man per day. He decided that for such work a first-class workman should only be under load for 43 per cent. of his time, and be entirely free from load for 57 per cent.; and worked out the working and resting periods. A man was persuaded to work under the scheme:—

> "Schmidt started to work, and all day long and at regular intervals, was told by the man who stood over him with a watch, 'Now pick up a pig and walk. Now sit down and rest. Now walk. Now rest,' &c. He worked when he was told to work, and rested when he was told to rest, and at half-past five in the afternoon had his 47½ tons loaded in the car. And he practically never failed to work at this pace and do the task that was set him during the three years that the writer was at Bethlehem."

That Schmidt was no exceptional man is shown by the fact that gradually the whole gang of workers were taught to load iron in this way at about the same pace, that is, four times more quickly.

The value to be got industrially from well-planned rest pauses in only slowly coming to be appreciated; though for long sustained athletic efforts it has long been recognised. The point for present consideration is whether advantage cannot be taken of a wage system to ensure that adequate rest pauses are taken. The Committee are satisfied that short rest pauses do not interrupt the rapidity of the work; for observations have disclosed that as the initial morning stiffness passes off output rapidly increases, but that in the afternoon, after the pause for the mid-day meal hour, the rapidity of output recommences at the level of the last hour of the morning shift. They would, therefore, be inclined to regard favourably any plan whereby rest pauses could be used as an incentive to work.

An imaginary example may be used to explain the method associated with a flat piece rate. Take a light repetition process calling for a rapid use of the small muscles of the hands and fingers. The working hours are taken at eight, *i.e.*, 480 minutes, and the average pace at which a number of articles, say 200, are submitted to the process is presumed to be 43 minutes. Then if a rest pause of five minutes were introduced after each spell of 43 minutes, 200 articles being then made, there would be 10 rest periods during an eight-hour day. If, however, a rapid worker dealt with his 200 articles in 35 minutes, he would then get a five minutes rest pause, 40 minutes in all; and if he continued to work at this pace would earn 12 rest pauses in the eight-hour period. A very slow worker on the other hand might only deal with 200 articles in 55 minutes, when he would get five minutes pause, 60 minutes in all; and working at this pace would only earn eight rest pauses in the day. If a worker's daily earnings computed in this way are plotted on a diagram it will be found that the curve of wages has a similar shape to that furnished by the premium-bonus system, but the

---

* Taylor, Fred W. "Principles of Scientific Management," 1911. Harper and Bros., New York.

result is reached by a very different route. The premium-bonus system curtails output by reducing the wages' incentive; the worker is allowed to work as hard as he pleases, but if he does more than a certain amount he will receive a very small extra reward. The present system curtails output by progressively decreasing the amount of time the worker is allowed to work. In effect, if the unit (200 articles of the illustration) is produced in " m " minutes, the worker can only produce $\frac{480}{m+5}$ units in an eight hour shift, that is to say if he could turn out his 200 articles in a moment of time, he would still be unable to produce more than 95 units, that is 19,200 articles, in the shift. Consequently, it may be said that the system is in no way superior to the premium-bonus system, that with a scale devised in this way a limiting point will be learned, and that output will be kept down to such a point. The answer is that if a limit is established, as may very well be the case, the quick workers will reap an advantage by having the time saved as definite rest periods instead of furtive " slacking." Further, the system might be improved by dividing the wages into two parts—(*a*) a piece rate computed as above, and (*b*) a time rate for the compulsory rest pauses, the rate being progressively increased with the number of pauses earned. The pauses need not necessarily be employed in doing nothing; sedentary workers employed at light work would benefit most from some form of exercise which calls the legs into action, and they might be set to tidy up their work place, or carry the articles treated to the next department, or fetch the next lot of articles to be treated, or indeed at any other occupation timed to occupy the rest pause, which gives exercise but does not entail use of the small hand muscles. Workers, on the other hand, employed standing at heavy physical labour would benefit most during the rest pauses by sitting down. Experience teaches that in practice workers always take rest pauses (*e.g.*, para. 27, page 23), and what is here advocated is only the organisation of such pauses so that they can be brought into harmony with the wage scheme and recognised as stepping stones in the daily progress of output. This method of distributing the day's work into a number of tasks is in itself an incentive to quick work; constant repetition of a process many times every day tends to produce monotony; but this is avoided by breaking the work up into a number of stages with a direct incentive to complete each stage, while the pleasure which comes from something done is steadily repeated.*

Objections, however, of substance may be made to this arrangement. In the first place, rest is made proportional to output, whereas it should be proportional to effort according to the theoretical basis of the scheme. Output is not a complete measure of effort when comparison is made between different persons under the same conditions, or in the same person under different conditions; nor, indeed, is any method known whereby effort could be adequately measured in practice. While, therefore, the plan might operate favourably for the average worker under average conditions, it would clearly be prejudicial to those who for one reason or another had little output to show after considerable effort; and in this way inefficient, weak or sickly workers would actually get less rest than the skilful and robust, though needing it much more. Still, both would obtain some rest. In the second place, managers of factories, wherein there are many and varied processes carried on, might, not unreasonably, object that the suggested plan is of such a complicated character that it would not be easy to carry out without an undue amount of supervision; only direct experiment can test the validity of this objection. And they may consider that discipline would be interfered with if each group of workers came and left at different times of day. The difficulty, however, would be overcome if well-considered rest pauses were introduced; these rest pauses would be longer for the more arduous processes, and shorter for the less arduous processes; and by careful adjustment the optimum number of hours, with rest pauses interposed, could be arranged for each process to coincide with the times fixed for the factory as a whole to start and stop.

The scheme outlined should not conflict with the practical necessity which has been demonstrated (*see* page 23) of employing workers at processes which call for different degrees of physical and mental effort for different lengths of time if maximum output is to be attained: the greater the effort, the shorter should be the hours.

But in a standardised industry such as the manufacture of munitions of war has now become, much work consists of tending machines, the speed of which largely controls the rapidity of output; and this speed is a direct stimulus to the worker to strive to keep the pace, with, as a result, danger to health and to safety, which may cause physical and mental exhaustion. The interpolation of rest pauses, definitely paid for, would go far to remove the injurious influence of this speeding up.

23. *Necessity for Instruction.*—When the task has been determined and the wages fixed, there still remains, closely associated with incentives to work, the necessity for teaching workers how to perform the task and so earn the wages.

The Committee think it strange that while soldiers are sedulously instructed both in drill movements, which are indirectly, and in rifle and bayonet exercises, which are directly of value to them in carrying out their duties in the field, munition workers, not less important contributors to our national defence, have to depend upon casual and haphazard information, or may be referred to technical schools which, however excellent, can no more replace factory instruction than can drilling in the park training in the field; and have noted that, though in the athletic world instructors exist to teach boxers how to balance themselves and use their arms, and cricket professionals are constantly at work improving the efficiency of batsmen and bowlers, and coaches are a necessity to teach a boat's crew collectively and individually how and when to move their bodies and hands, yet in the industrial world the value of teaching operatives how to earn their livelihood is hardly yet recognised. In America much has recently been done, in association with what is known as " scientific management," to eliminate useless movements and lessen physical effort, but, somewhat unfortunately, the

* A concrete instance of introducing rest pauses totalling 15 minutes in every hour at a light repetition work, the output of which became three times that previously obtained, is given on pp. 127–129 of "Fatigue Study," by F. Gilbreeth, 1916, G. Routledge and Sons, Ltd.

subject has got wrapped up with " time studies " used for fixing piece rates, and there is, in consequence, a tendency for it to be looked on with disfavour by wage-earners, while the real value of teaching is being lost sight of. The Committee feel no doubt that just as the athlete obtains further incentive to skill by seeking information as to his faults from a trained teacher, so should operatives be able to turn for instruction as to wasteful and non-productive practices unconsciously developed, and as to methods of improving their work with less effort, and that such teachers would be able to give useful advice to the management as to the most suitable speed for running machinery and as to the best moment to choose for rest pauses. The ideal foreman should be such a teacher, but foremen who consider such duties part of their daily work are seldom found.

APPENDIX.*

1. This Appendix describes some of the different systems of wage payments which are adopted in connection with piece work. No attempt is made to judge the systems on economic, ethical or physiological grounds, but merely to reduce the working of each to comparable terms. At some points algebraical equations have been introduced as such expressions will make the argument clearer to some readers; but those who dislike this form of mental shorthand can pass over the equations without loss of continuity for arithmetical examples are given in each case.

2. In munition works *the large majority of the employees are engaged in repetitive work, and the different systems will only be considered in relation to such work,* that is to say, the systems will be expressed in terms of total earnings for a day of arbitrary and constant length, viz., 10 hours when varying numbers of articles are produced by different individuals.

3. Many forms of piece rates are in use; to understand them the basis on which they rest must be considered. Every industrial establishment in which they are employed has two forms of expenditure:—

(1) The expenditure which represents—

(*a*) interest upon capital sunk in land, buildings and manufacturing plant;

(*b*) taxes, depreciation and insurance;

(*c*) the wages paid to managers, clerks, skilled experts such as chemists and mechanics, foremen and general labourers, who are all paid by time; and

(*d*) such items as the cost of driving, shafting and of lighting the premises.

All this group of expenditure (provided the whole of the plant is utilised, and that the number of employees is kept constant) is fixed whatever the output of the factory, and is known as overhead charges; and

(2) Expenditure upon wages paid by the piece, upon the cost of raw material manipulated, and upon the cost of power consumed by the machinery when in action (a relatively small item); all the items in this group vary directly with the output.

4. If such an establishment has a 10-hour working day, and a calculated output of 100 articles, the price charged for these articles must be the sum of the expenditure per diem on overhead charges and the piece wages paid for making 100 articles, together with an item added for profits. If now by speeding up production 120 articles are produced in the 10 hours instead of 100, and the selling price is not altered, the cost of production will only be higher as compared with that of the original hundred in respect of the cost of the extra raw material, the extra piece wages, and the extra power used and wear and tear of machinery. In other words, the additional 20 articles add nothing to any of the items under (1); and the firm can therefore afford to pay a higher rate of wages for their production, and still make greater profits. Or again, since the price of 10 articles carries the overhead charges for one hour, if 12 articles are made in that time a higher rate can be paid for the two extra articles. Based on these considerations, the simplest form of piece rate would be a plain piece rate of so much per piece until the incubus of overhead charges has been lifted, and then a rise which may take the form of a definite sum, or bonus, for completion of the task, or of a higher piece rate for further articles made.

* The Committee desire to thank Capt. M. Greenwood, R.A.M.C., Statistician to the Lister Institute, for assistance in preparing this Appendix.

5. This form is simple and easily understood, but in practice only the more rapid workers would attain the high piece rate, and it fails to be an incentive to many of the workers. In order to provide for this, the progressive piece rates for the manufacture of the first instalment of articles which are to carry the overhead charges, say 90 articles, might be introduced. Thus, say the expenditure which can be set aside for piece wages has been fixed at one penny for each article, the scale may be on the following plan:—

For the	first	10	articles	6 pence.
„	second	10	„	7 „
„	third	10	„	8 „
„	fourth	10	„	9 „
„	fifth	10	„	10 „
„	sixth	10	„	11 „
„	seventh	10	„	12 „
„	eighth	10	„	13 „
„	ninth	10	„	14 „
		For 90 articles 90 pence.		

Such a scale would provide an incentive for even slow workers to climb by a higher rate of production to a higher rate of pay; and a sudden rise from, say, 10 pence for every 10 articles until 90 are made, to 16 or 17 pence for every 10 articles over 90 is avoided.

6. The only economic difficulty in such a progressive scale seems to be that if the progression is too rapid and the capacity of workers has been under-estimated, the workers may climb to a piece rate which absorbs the sum profitable to pay, even when overhead charges have no longer to be considered; and it would be to the employer's interest to slow down production or " cut " the piece rate. In order to guard against such a state of things arising, systems have been devised in which the " bonus " varies with the selling price of the product; and progressive piece rates have been introduced in which the increment is not regular, but is slightly less at each advance, and is so arranged that it can never exceed the amount of overhead charges; thus presume that overhead charges are distributed over 90 articles at one penny per article; and piece wages are also at one penny per article; after the first 90 are made at this price the firm can afford to pay piece rates up to twopence per article, but not above. The advancing piece rates in this case would be so arranged by decreasing increments that twopence per article cannot be exceeded.

7. These remarks are introduced to enable the reader to grasp the general conditions of the problem which ought to be solved by an ideal wages system. The plans may next be considered which have actually been tried, exclusive of those which to a greater or less extent aim at the realisation of a co-operative ideal by taking selling price or profits into consideration.

SYSTEMS OF PIECE RATES.

8. (1) *Straight Piece Rates without a Minimum Wage.*—This is the simplest conceivable case. Let us suppose that the piece rate is one penny per article. Then if in 10 hours the man produces 0 articles he receives nothing; if he produces 10 articles he receives 10 pence; if he produces 100 articles, 100 pence, and so on. The wages curve is a straight line, or expressed otherwise, $Y = mX$, where Y is the wages, m the price per piece, and X the number of pieces produced in standard time.

9. (2) *Piece Rates with a Minimum Wage.*—In practice System 1 is not usually adopted, but a minimum wage is generally paid to all workers, however little they produce, and the piece-rate system only comes into operation after a certain minimum number of articles has been exceeded.

The following deductions can be made at once:—

(1) If the piece rate be fixed at the rate per article found by dividing the minimum wage by the number of articles beyond which piece-rate payment comes into force, then, the more the worker produces, the lower will be the price paid per article of his production, until he has produced the standard number.

(2) Equal increments of production bring equal increments of earnings beyond the point corresponding to the standard, but not from zero.

These deductions will appear to most readers self-evident, but as they are of fundamental importance, it is well to give some illustrations. Let us suppose that the minimum wage for 10 hours is 50 pence and that piece payments begin when 100 articles have been made and are calculated at the corresponding rate, viz., 100 articles for 50 pence, or ½d. an article. Then the man who only produces one article is paid 50 pence for it, if he produces two articles he still receives 50 pence, or 25 pence for each article, and so on, his rate per article steadily decreasing to a minimum of ½d. per article, and thereafter remaining constant, which is deduction (1).

The same illustration shows the truth of deduction (2), since, for every additional article produced from 1 up to 100, the man receives no addition to his wages, while, for every addition beyond 100 he receives an identical increment, viz., ½d. per article.

10. (3) *Piece Rates with a Minimum Wage, the Piece Rate being less than the Standard Piece Rate.*—These systems cover the great majority of the " premium " or " bonus " or " premium bonus " systems; indeed, with certain modifications to be noted, which are only modifications of detail, not of principle, the systems of Halsey, Emerson, Weir and Gantt all belong to this class.

The order followed in the previous paragraph will be reversed, and a particular illustration given before the general principle is stated.

Suppose that, as before, 50 pence are the minimum wage for 10 hours, and 100 articles the standard production. Then the position of a man under the present system is exactly as under 2 until he has reached a production of 100 articles. Now suppose that further production is not paid for at the rate of ½d. an article, which is the rate paid the man who produced the standard number in the standard time, viz., 100 articles in 10 hours, the 10 hours' pay being 50 pence, but at half this rate, viz., at ¼d. an article. Then, for every extra article beyond 100 he will receive an extra ¼d., so that deduction (2) of last paragraph still holds. But deduction (1) is no longer true; the price paid for each article in his output continues to diminish after the standard production has been reached down to a rate of ¼d. an article. The concluding words of deduction (1) " until he has produced the standard number " must be omitted. If, for instance, he produces 200 articles he will be paid 50 pence, plus 100 times ¼d., or 75 pence in all, which is at the rate of ·375 pence per article for his whole output. Had he produced 300 articles he would have received 50 pence, plus 200 times ¼d., or 100 pence in all, a rate per article ·3333 pence. The rate paid per article steadily diminishes, but, and this is of the essence of the matter, it does not diminish indefinitely; it can never be less than ¼d. per article. Suppose he produces some incredibly large number, say a million articles more than the standard number of 100. His receipts will be 50 pence, *plus* a million farthings, that is, 250,050 pence, which gives, dividing by 1,000,100 (the number of articles produced), a piece rate of ·25002 pence per article. This can be seen at once if we express the facts in algebraical symbols. Let Y represent the price paid per article of the man's total production, W the minimum wage, K the number of articles beyond which a piece rate is paid, and p that rate; also let X be the man's output in excess of K, so that K + X is his total output. Then we have:—

$$Y = \frac{W+pX}{K+X}.$$

Now when X is very large indeed, W and K become insignificant in comparison with pX and X, so that the expression reduces to p multiplied by X and divided by X, *i.e.*, it becomes equal to p, which in our illustration was a farthing. The reader will note that the curve is a rectangular hyperbola, $Y = p$ being an asymptote.

System 3 therefore differs from System 2 in that the piece rate diminishes down to a finite minimum. On the other hand, the *total earnings* increase indefinitely, for the total earnings are W + pX, and the only difference between the curves representing the total earnings of Case 2 and Case 3 is that in Case 2 p is equal to W/K, while in Case 3 it is less than W/K. In geometrical language this means that both curves of total earnings are straight lines rising from W as an origin, but the rise is less steep (in our illustration just half as steep) in Case 3 as in Case 2.

These very simple propositions must be thoroughly understood; failure to grasp them has caused a vast amount of confusion in the statements made respecting premium systems.

These results may be summarised by saying that systems of type 3 enable the employee to increase his total earnings from the point of reaching the standard by equal increments of money for equal increments of production, and that there is no *theoretical* limit to the amount he may earn. If he produced an infinite number of articles he would receive an infinite sum in wages. On the other hand, the employer pays the employees who have passed the standard progressively less per unit of production, but he never pays less per unit than a certain finite amount. From his point of view the law is one of increasing average returns.

Again, looking at the same facts from a slightly different point of view, there is no amount of production, increases beyond which will return the employee no finite increase of reward. The significance of this fact will appear later.

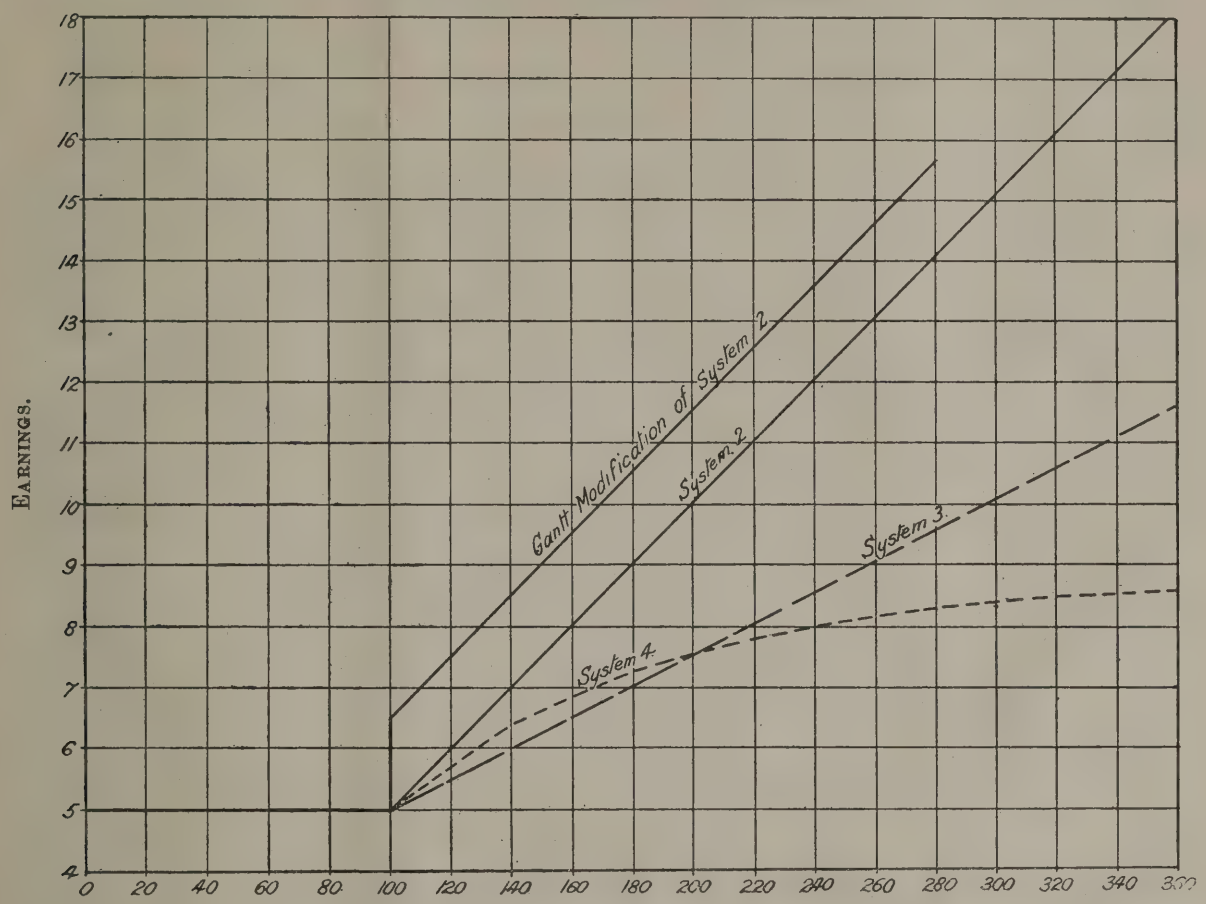
11. It has been said that this system comprises the majority of bonus systems. It will be sufficient to demonstrate this by an examination in detail of one such system, viz., that of Mr. F. A. Halsey. Mr. Halsey described his plan in detail in a paper entitled " The Premium Plan of Paying for Labour," published in the first volume of the *Economic Studies* of the American Economic Association, which appeared in 1896 (Supplement pp. 75, &c.). Mr. Halsey and others have, of course, issued many subsequent papers dealing with the subject, but none of these, so far as is known, affect the principle which alone is now under consideration. An analysis of the table annexed, which is extracted from Mr. Halsey's paper, will afford all the information required.

This table (*see* page 81) is expressed in terms of one particular task, and to bring it into line with the general plan it must be reconstructed. It will be assumed, then, that the task standardised for 10 hours consists, as before, of making 100 articles. It follows, then, that the man who could produce the 100 articles in nine hours would have produced 1,000 divided by 9, or 111·11 articles in 10 hours, and similarly for the other values. But these amounts do not increase by equal increments, so that the table expressed in terms of earnings for different amounts produced is not easily understood. It is seen at once, however, that if the man can produce the 100 articles in five hours, that is, if he produced 200 articles in 10 hours, his wages would be not six dollars, but four dollars, or increased by a third instead of by 100 per cent. This suggests that the system is probably System 3, with p equal to one-third of W/K, and we shall show that such is the case.

TABLE 1.

Time consumed.	Wages, per piece.*	Premium.	Total cost of work.	Earnings, per hour.
Hours.	$	$	$	$
10	3·00	0	3·00	·30
9	2·70	·10	2·80	·311
8	2·40	·20	2·60	·325
7	2·10	·30	2·40	·343
6	1·80	·40	2·20	·366
5	1·50	·50	2·00	·400

CHART TO ILLUSTRATE SYSTEMS.



PRODUCTION.

Let H be the number of hours required by the man to produce the standard task of K articles. Then he receives for K articles:—

$\frac{HW}{10} + (10 - H)P.$, where W is the minimum day wage and P is the premuim. His piece rate is $\frac{\frac{HW}{10} + (10 - H)P}{K}$, but the faster his production, the smaller the number of hours required to produce K articles, so that his piece rate diminishes from $\frac{W}{K}$ when H = 10 to

$$\frac{10P}{K} \text{ when } H = 0. \qquad \frac{W}{K} \text{ is } \frac{300}{100} = 3 \text{ cents.}$$

$$\frac{10P}{K} \text{ is } \frac{100}{100} = 1 \text{ cent, } i.e., \text{ one third of } \frac{W}{K}.$$

The *total earnings* are as before, given by a straight line.

$$Y = W + \cdot 33 \frac{W}{K} X.$$

The reader can satisfy himself that this is correct bv comparing the results with the last column of Mr. Halsey's table, *e.g.*, if 111·11 articles are produced in 10 hours—

X = 11·11 and Y = 300 + 11 = 311 cents for 10 hours, or ·311 dollars for one hour.

* This heading does not mean *per piece* in the sense of our text; it is really *time wage earned at standard rate* of $3 per hour.

In other words, the table quoted from Halsey's paper is a typical example of System 3, the piece rate for output beyond the standard being one third the rate paid to the standard producer instead of one half as in the former illustration.

12. There are many modifications of this system; for instance, that of Emerson. These modifications consist in changing the earnings *below* the standard. In the case we have described, the diagram expressing total earnings as a function of output is a horizontal straight line for all outputs up to the standard and then a straight line inclined at an angle to the horizontal. Now by introducing the premium method below the standard, for instance, by crediting the producer of something less than the standard output with a certain premium which is larger the nearer he approaches the standard, the horizontal line of total wages for producers of less than standard quantities can be altered. But, if there is a minimum day wage, and if the piece rate for production in excess of the standard is less than the piece rate for the standard calculated as before and is constant, the two main features of System 3 will be reproduced. An application of this test is all that is necessary to determine whether any given wages system falls into the class. We shall apply it to the Emerson system as described by Professor Hoxie (*Scientific Management and Labour*, page 72). Here for each 1 per cent. increase in production above the standard the worker receives 1 per cent. increase of wages in terms of a minimum wage. The standard producer receives 120 per cent. of the minimum. Suppose 100 articles in 10 hours to be the standard, and 3s. the day wage, then the producer of 50 articles receives 3s.; the producer of 100, 3·6; and 200, 3·6 + 3·0 = 6·6; piece rates of ·06, ·036 and ·033 respectively. The piece rate for producers beyond the standard is $\frac{3\cdot6+n\times\cdot01D}{100+n}$ (n=production beyond 100, and D=day wage), which becomes ·01D when n is infinite, *i.e.*, it diminishes down to ·030.

The Gantt System (Hoxie *op. cit.*, page 68) on the other hand is an example of Class 2, with discontinuity. All workers who fall below the standard receive a day wage. The standard producer receives a sudden increase of 30 per cent., and the producers beyond the standard receive the same piece rate as the standard producer.

The curve is a horizontal line for all outputs below the standard, then the line rises at right angles to a point 30 per cent. of the previous distance between the horizontal line and base line above the former, and from this point the piece rate line of System 2 commences. (*See* Chart.)

Before leaving these systems it should be noted that the objection urged against them, viz., that equal increments of work do not earn equal rewards must be true of any conceivable wages system provided that a minimum time wage is enforced, and is quite as true of System 2 as of System 3 (geometrically, of course, System 2 is only a particular case of System 3). Conversely the arguments in their favour, (*a*) that it is reasonable to share the profits between the employer and the employee, and (*b*) that they obviate the necessity, from the employer's point of view, of cutting rates, are hardly sound. Argument (*a*) is only true if the employer make no profit at all from the worker, who produced the standard quantity or less. Argument (*b*) is only true if the piece rate paid for production above the standard is so small that the inclination of the straight line rising from the horizontal is inappreciable, in which case there is no sensible pecuniary inducement to the worker to produce more than the standard, and he can hardly be expected to do so. All that the system secures is that the workers' increase in earnings with increase of output shall be slower than if System 2 were adopted. On the other hand, System 4, to which we now come, does, indeed, completely secure the employer against ever having to pay more than a certain sum in wages, however great the output.

13. (4) *Piece Rate System with Minimum Wage, the Piece Rate Diminishing without any Limit.*—This system which, very unfortunately, has been called *the* Premium-Bonus System, is a method of keeping the total wages' cost down to a certain amount, *however great the production*, and at the same time of securing the worker a minimum wage for his day's work. The reader, with a slight knowledge of algebra, will recognise that these objects can be very easily attained. Thus, if we decide that no man shall earn less than W pence for his day's work, and that no man shall earn more than twice W pence, however much he does, we can pay him wages calculated from the following formula:—$Y=W(2-1/x)$, where x is the number of times the standard amount he actually produces, and only values of x greater than 1 are employed. If he produces exactly the standard amount he will earn W. If he produces twice the standard amount he will earn one and a half times W, and if he produces an indefinitely large amount he will earn twice W, and can never earn more than twice W. This, which, be it remembered, *is not the curve of piece rates but the curve of total earnings*, is a rectangular hyperbola with Y=2W for horizontal asymptote.

The system was devised by Mr. Rowan, and we quote his table (*American Machinist*, 1902, Vol. XXV, page 49):—

Wages rate, $·30 per hour.

Table 2.

Hours allowed.	Hours taken.	Time wages on job.	Premium earned on job.	Total cost.	Workman's rate per hour.
		$	$	$	$
100	100	30·00	·00	30·00	·30
100	90	27·00	2·70	29·70	·33
100	80	24·00	4·80	28·80	·36
100	70	21·00	6·30	27·30	·39
100	60	18·00	7·20	25·20	·42
100	50	15·00	7·50	22·50	·45
100	40	12·00	7·50	19·20	·48
100	30	9·00	6·30	15·30	·51
100	20	6·00	4·80	10·80	·54
100	10	3·00	2·70	5·70	·57
100	1	·30	·297	·597	·597

It will now be shown that this table can be expressed by the formula given above. From the table we see that if a job standardised for 100 hours is completed in, say, 80 hours the workman receives 80 × hourly wage of ·30, plus $\frac{100-80}{100} \times 80 \times$ hourly wage $= 24 + 4 \cdot 8 = \$28 \cdot 8$.

In symbols :—

$$\text{Amount earned in } t' \text{ hours} = t'h + \frac{(t-t')ht'}{t} = t'h\left(2 - \frac{t'}{t}\right) \quad (1),$$

Where t is standard time, t' actual time and h hourly rate. But if the standard task is taken as unity, the man who can complete it in t' hours will do $\frac{t}{t'}$ times the standard in t hours.

This is x of the formula on p. 82, para. 13. Multiply (1) by $\frac{t}{t'}$, and substitute $\frac{1}{x}$ for $\frac{t'}{t}$ in the bracket, and we have

$$\text{Amount earned in } t \text{ hours} = ht\left(2 - \frac{1}{x}\right) \quad (2);$$

but

$$ht = \text{wage for } t \text{ hours} = \text{W},$$

so (2) becomes

$$y = \text{W}\left(2 - \frac{1}{x}\right),$$

which was to be proved, y being the amount earned.

This is the total amount received for producing x times the standard output. If the standard output is 100 articles, the piece rate paid to a man who produces 100 x articles in time t is

$$\text{W}\frac{\left(2 - \frac{1}{x}\right)}{100x},$$

which diminishes from $\frac{\text{W}}{100}$ to zero as x increases.

14. Certain consequences follow from the above investigation. From the nature of the curve of earnings, there is a considerable pecuniary inducement to exceed the standard to a moderate extent, greater indeed than by System 3, but the inducement rapidly diminishes and becomes practically insignificant. These points are brought out by Table 3. System 4 offers a greater temptation than System 3 to do 50 per cent. better than the standard. On the other hand, while an increase from three times to three and a half times the standard output is rewarded by an increase of one shilling and three pence under System 3 it only earns a trifle more than 2½d. under System 4. Consequently in the case of purely repetitive work, the system is admirably calculated to give rise to artificial limitation of output, unless the standard production is fixed so high that very few workers are able to do more than, say, 50 per cent. better than " bogie."

This appendix is not, of course, concerned with anything beyond a description of the systems, but it is fair to remark that the method under notice was not apparently devised in a factory engaged upon work of a mainly repetitive character. Thus, it has been remarked (*American Machinist*, XXVI, 17th October, 1903):—" The work done in the Rowan Works is the building of marine engines, in which, of course, there is little repetition work—a fact which accounts for the emphasis which Mr. Rowan always places on the importance of the rate fixing department."

TABLE 3.

Working of Systems 2 to 4.—In the case where the standard production is 100 articles in 10 hours, and the day standard wage 5s., piece rates ·05 for System 2, and ·025 for System 3.

Production.	Total earnings (shillings).		
	System 2.	System 3.	System 4.
100	5·0	5·0	5·0
150	7·5	6·25	6·67
200	10·0	7·50	7·5
250	12·5	8·75	8·0
300	15·0	10·0	8·33
350	17·5	11·25	8·57

SUMMARY.

15. The various methods which have been described (all of which, excepting the first, are known to be employed in different munition factories), can be conveniently contrasted as follows:—

A.—From the Point of View of the Operative.—

(1) Following a law of constant rate of remuneration. (System 1.)

(2) Following a law of diminishing rate of remuneration.

(*a*) Rate of remuneration diminishing to the rate corresponding to the earnings of "bogie," and return constant from that point. (System 2.)

(*b*) Rate of remuneration diminishing down to a rate which is some finite fraction of the rate earned by "bogie." (System 3.)

(*c*) Rate of remuneration diminishing without any limit. (System 4.)

B.—From the Point of View of Pecuniary Incentive to Production.—None, except the Gantt modification of System (2)*, offers any incentive to the worker who is only just able to equal "bogie." Systems (2) and (3) provide a constant incentive to the workers who can pass "bogie" to continue their efforts. System (4) provides a greater incentive than System (3), as illustrated, to workers to surpass "bogie" by a moderate amount, but as the production increases further the incentive falls behind that provided by System (3), and rapidly becomes infinitesimal.

---

* The special feature of the Gantt System is carried further in the Systems of Taylor a new and higher rate being introduced discontinuously as the worker reaches various stages of increased production. These methods are not known to be used in any factories studied by the Committee, and the reader is referred to the work of Hoxie cited in the text, for further information.

PART II.

MEDICAL STUDIES.

REPORT ON THE HEALTH AND PHYSICAL CONDITION OF MALE MUNITION WORKERS.

By

Capt. T. H. AGNEW, R.A.M.C.

CONTENTS.

SCOPE OF INQUIRY.

1. In arranging for these inquiries, the Committee were actuated by a desire to obtain medical evidence as to the nature and extent of the ailments and defects from which the workers were suffering, the amount of fatigue existing amongst them and the means of alleviation which might be adopted.

The inquiry extended over a period of six months, from the middle of February to the middle of August, 1916. During the first half of this period I had the assistance of Mr. Heath, of the Factory Department of the Home Office, to whom I am indebted for some of the details elicited in the conduct of this inquiry. I desire also to place on record my obligations to the management and the men of the factories visited. Everywhere the inquiry was facilitated by the readiness of the examinees to answer questions, both general and particular, and by the anxiety of the management to remove, so far as possible, any cause of difficulty or hindrance.

2. Eight factories were selected for the examination, the works being situated in four of the principal industrial areas of England. The class of munition work upon which the operatives were engaged varied within wide limits. The principal processes followed were anti-aircraft gun making, limber mounting, big gun manufacturing, shell stamping, fuze and gaine making, bullet and cartridge case making, exploder bag filling, gunpowder pellet making, cartridge filling. Next came the inspection of the processes of rifle and auto-machine gun manufacture such as stamping parts, gun-stock turning and polishing, barrel rifling and sight testing, steel smelting, gas producing, forging naval guns, naval shell making, steel rolling by both hot and cold processes, field gun shell pressing, aeroplane building and ambulance construction.

3. In all, 3,052 workers were examined—1,543 men and 1,509 boys—distributed as follows:—

In factory	1	...	...	532	men	and 88	boys.
,, ,,	1	(return	visit)	0	,,	,, 900	,,
,, ,,	2	...	...	376	,,	,, 124	,,
,, ,,	3	...	...	137	,,	,, 73	,,
,, ,,	4	...	...	61	,,	,, 29	,,
,, ,,	5	...	...	152	,,	,, 97	,,
,, ,,	6	...	...	240	,,	,, 91	,,
,, ,,	7	...	...	45	,,	,, 15	,,
,, ,,	8	...	...	0	,,	,, 92	,,

4. The men chosen were 41 years of age and upwards and the boys 18 years of age and under. The reasons for this selection were:—(*a*) That any baneful influence which unhygienic surroundings and long hours might exert would probably be mostly manifested during youth or middle age—during youth because growth is proceeding and the reaction to environment may be expected to be more acute—during middle age because these workers have already been submitted to many years of industrial life; (*b*) at the present time so many of the physically fit have been withdrawn from industrial to military service that the residue between the ages of 18 and 41 years might reasonably be expected to be below the normal standard.

5. Before commencing the examination of the workers, a general survey of the workshops was made, in order to ascertain the nature of the process or processes conducted, the amount of strain to be endured and the number of men engaged. After this information had been obtained concerning every workroom in the factory, a representative group of men and boys was chosen for examination. The reasons for making the inquiry were explained clearly to the shop managers, to the men and to the boys alike. Appreciation of the purpose of the Committee's inquiry was shown by the readiness to submit to examination and to answer questions, and often to add information quite irrelevant but occasionally useful to the nature of the inquiry. The scope of the examination of each worker was limited by the necessity for interfering, as little as possible, with output, and generally occupied about 12 minutes. The scheme adopted in every case was a careful examination of the radial pulse recorded by a "watch count"; the heart and lungs were next examined, apex beat and chest expansion being noted. The measurement of blood pressure and of chest expansion had unfortunately to be eliminated owing to lack of time. Next in order of examination were the nose, mouth, teeth and pharynx, particular attention being paid to the latter in the case of juveniles. Questions upon the digestive system were answered clearly and freely. Sometimes information relevant to the general nervous system was given with hesitation, but in the main the questions were understood and replied to readily. The condition of the eyesight only called for close observation in a minority of those examined, because (i) the majority of the processes were unlikely to cause eyestrain, (ii) a very large number of the men examined had had their vision carefully tested before being taken on for work, and (iii) in those cases where strain was made upon the eyes, defects had already been adjusted by spectacles, or, where suspected, the eyes had been examined by an ophthalmic specialist; in all cases the desire to be equal to the work and to earn as much money as possible were the reasons for this precaution. All operatives were examined for flat foot or any other pedal deformity likely to cause inconvenience. In all those processes necessitating long standing, the legs were examined for the presence of varicose veins.

In order that the data elicited during these inquiries should be as reliable as possible, the examinees were classified solely upon the result of their medical examination, and the considerations of their hours of labour and the conditions of work upon which they were engaged were not referred to until compiling the reports upon each factory.

6. As a method of eliciting the effects of labour and environment on health, this procedure is open to obvious criticism. Men who are sick or dead are not found at work, and any complete survey would include the condition of those who are temporarily absent as well as of those who have permanently retired from the particular sphere under investigation. There are, however, good grounds for thinking that conditions of work which cumulatively result in severe illness and death may be presumed to leave in the factory indications of their operation in the form of milder examples of illness of the same kind or of similar origin, and that to some extent at any rate this index would be quantitative. This relation, however, is doubtless influenced by the process of selection which goes on more or less continuously, whereby those who are unfit become eliminated altogether or segregated to particular kinds of work. The extent and intensity of this selection will necessarily vary with the fluctuations between industrial demand and the supply of labour, and it is with a shortage of labour, such as now exists, that we should expect selection to be at its minimum and the health standard therefore at its worst. These difficulties cannot be solved with the present data; we can only bear them constantly in mind in interpreting the results of an inquiry such as the present.

Classification of Occupations.

7. For purposes of analysis the work done by each man and boy has been assigned to one of four categories, and the figures set out in Tables 1 and 2 under the various headings show clearly the numbers of individuals engaged upon various classes of work The groups are arranged partly according to weight of work, partly according to the conditions of heat, noise, &c. In factories 1, 2, 3, 5 and 6 the very heavy and heavy processes were most frequently followed. Whilst at some of these the men were more fully engaged upon very heavy work, others were occupied in processes which involved both very heavy and heavy labour, but for the purposes of classification in the tables they have been grouped according to the work upon which they were found engaged.

(*a*) The *very heavy group* includes such processes as steel making, naval gun forging, smithy work where hammers of 18 pounds weight and upwards were used, the forging of 12-inch and 15-inch naval and field shells. Smiths wielding hammers of 25 or 30 pounds weight and dealing with very heavy materials in the smithies have been also included in this category because their work is continuous and involves the expenditure of great energy and exposure in most cases to excessive heat.

(*b*) *Heavy Group.*—Amongst the men occupied in the heavy trades have been included smiths wielding hammers of a less weight than those referred to above; labourers in steel yards, because some of these men in the course of their work lift very heavy weights, but have the advantage of following their occupation chiefly in the open air; men wheeling large quantities of metal, bricklayers, ordinary labourers, forgemen engaged upon the lighter class of work, men making the small shells such as the 4-inch and below, gas producers, navvies, men engaged in stamping shops, have been included in this category because the temperature to which they are ordinarily exposed, though high, are not nearly so high as in the processes referred to as "very heavy." There is occasionally some overlapping, as I have already mentioned.

(*c*) *Medium Group.*—Between the former processes and the medium and light processes there is a distinct difference. Occasionally some difficulty arose with reference to the class into which an examinee should be put. Often this was settled by the fact that a workshop was very noisy, though the work upon which the individual was engaged was light, and decided his inclusion in the medium group Those processes classed medium included automatic machine minding, the majority of shell turning processes, gun stock turning and polishing, barrel rifling, fuze and gaine turning, the various processes of limber mounting, and gun sighting for anti-aircraft work. In the majority of these cases the conditions under which these processes were carried out were such as not to add materially to the weight of work. Amongst the boys a large number has been classified in the medium group owing partly to the weight of their work, and partly to the excessive noise in the factory. Many of these boys had been engaged for a comparatively short time, and though the work was apparently easy, yet at the same time the noise, in my opinion, would influence very considerably their conditions at the end of a working day. This particularly refers to the boys in the bullet and cartridge making factories from amongst whom large numbers were chosen for examination.

(*d*) *Light Group.*—In the light processes, for boys particularly, little or no effort was called for. The majority were seated at their work and the common processes were gun powder pellet making, exploder bag filling, breaking down gaines and fuzes, and cartridge filling. These occupations were all very easy and called for no physical effort. The men included in this category are those who are occupied in such work as sweeping up shops, acting as shop foremen, viewers of shell work, leading hands whose time is spent in walking about, and supervisors.

8. Similarly the standard of health and physical conditions of each examinee has been summarised as being:—

A	... ...	good;
B	... ...	slightly below normal;
C	... ...	much below normal; or
D	... ...	bad;

and this grouping is used throughout this Report.

GENERAL RESULTS OBTAINED.

9. The whole series of 3,052 men and boys examined give the following summary result:—

	Men.	*Boys.*
Class A ...	1,198 or 78 per cent.	1,374 or 91 per cent.
Class B ...	264 ,, 17 ,,	119 ,, 8 ,,
Class C ...	75 ,, 5 ,,	13 ,, 1 ,,
Class D ...	6 ,, 0·4 ,,	3 ,, 0·2 ,,
Total ...	1,543	1,509

It is evident that there is no very gross degree of ill-health prevalent among those at work; the figures suggest a fairly satisfactory position, though the absence of any standard of comparison renders accurate evaluation impossible. It should be noted that the main facts cannot be substantially changed by any reasonable assumption about absentees from illness at the time of the inquiry (*see* para. 12).

RELATION OF GENERAL HEALTH TO LENGTH OF EMPLOYMENT, HOURS AND NATURE OF WORK.

10. The data regarding health, length of employment, hours of labour, and nature of work, have been summarised in Tables 1 and 2. These tables are complex, and it is necessary to analyse their contents.

In the first place I suspected that the men and boys employed before the war, that is to say, those who were already in munition factories upwards of two years ago, could not properly be regarded as in the same class as those engaged since. These pre-war employees are a product of a long period of industrial selection, and entered the trade at a time when the supply of labour was not so restricted as it became after the outbreak of war. Hence a larger proportion of physically fit men might be expected amongst them, the weaklings, or poorer ones I should say, falling out through dismissal or through some other form of elimination. This presumption is verified by the fact that the percentage of men placed by me in class A is greater in the case of the pre-war men (80%) than for those men engaged since (74%).

The three remaining groups, all composed of men and boys who were engaged after the outbreak of war, and therefore during a period when selective elimination became difficult or almost impossible, are comparable one with another as regards the remaining factors. Three variables are involved, namely—(1) length of hours, (2) general health, (3) length of time employed; and what the Committee particularly wished to know is whether (1) and (2) are associated.

In Tables 3 to 6* the material is arranged with the object of bringing into comparison general health and length of hours. The four-fold arrangement has been adopted for convenience of comparison, and is justified by the facts that the characters classified are continuous and the numbers in the extreme classes (very long hours and fitness below B, for instance) are small. The comparison shows that the percentage in class A is less among those working longer hours, that is 70 hours or over for men and 60 hours or over for boys In three of the tables the difference is more than twice the probable error, and the combined improbability that all four tables should merely, as a result of random sampling, give the observed deviations is considerable, indeed the odds against it are about 99 to 1. The long hours, therefore, appear definitely prejudicial to physical well being, but it is necessary to be sure that this deduction is not deceptive and that it is not due to the intervention of the third variable, namely, length of employment. Thus it might happen that a larger proportion of the employees who had

* I am deeply indebted to Captain Greenwood for the elaboration and arrangement of Tables 3 to 22.

been engaged for longer periods, say over 12 months, worked shorter hours, and that they were by a process of selective elimination physically fitter, quite independently of the fact of working shorter hours. In this way a spurious association between short hours and physical fitness might arise.

Tables 7 to 14 were prepared to test this objection. Taking them seriatim we note:—

(i) There is very little difference between the percentages of A in the case of men on very heavy and heavy work when the classification by length of employment is adopted, and a similar remark applies to men on medium and light labour. In both cases, however, the hours are shorter for the men longer employed.

(ii) In the case of boys on light and medium labour, the boys more recently engaged are significantly fitter (the measure being as usual the percentage of A), but in this case the hours are significantly shorter. This case can be instructively compared with that of the men. The corresponding table for boys on very heavy and heavy labour records no differences which are significant.

These tables, therefore, in no way weaken the impression derived from Tables 3 to 6, namely, that there is a real relation between unfitness and long hours. Additional evidence pointing the same way is furnished by Tables 15 to 18. Each of these is derived from samples of men or of boys of the same grade of experience, and in each case the percentage of A is greater among the employees on shorter hours Any one of these tables taken alone would not warrant the conclusion suggested, but their concurrent testimony is of great importance.

Passing now to the pre-war employees, Tables 19 to 22 should be examined. The number of pre-war boys is small to support averages which would merit discussion, but the men provide a very instructive comparison with those dealt with above. In the case of light and medium work there is no appreciable difference between the general physical condition of those working longer or shorter hours. But in the case of heavy and very heavy labour there is a substantial difference in the opposite direction to that found in all the post-war tables, and those working the longer hours are seen to be actually the healthier body of men. The result is what might be expected if the hypothesis of industrial selection is true. In pre-war days the less fit were forced through selective elimination to join the ranks of the unemployed, or became unemployable when labour was plentiful and cheap; the demands of the employer for labour were easily met, and no particular thought was given to those who suffered through physical disability, the result of long hours or heavy work or both combined. But to-day when labour of almost any class is valuable, the seriousness of this question has become apparent.

Table 1. **Number of Men Examined in certain Munition average hours worked weekly, heaviness**

General Health. A—good. B—slightly below normal. C—much below normal.

Duration of Employment.	Net average hours worked weekly.	Very heavy process.					Heavy.				
		A	B	C	D	Total.	A	B	C	D	Total.
Under 6 months.	Under 60	2	2	—	—	4	6	4	—	—	10
		18·2	18·2	—	—	36·4	8·3	5·6	—	—	13·9
	60—70	5	1	—	—	6	27	6	—	—	33
		45·4	9·1	—	—	54·5	37·5	8·3	—	—	45·8
	70—80	—	—	—	—	—	13	5	1	—	19
		—	—	—	—	—	18·1	6·9	1·4	—	26·4
	80—90	1	—	—	—	1	9	1	—	—	10
		9·1	—	—	—	9·1	12·5	1·4	—	—	13·9
		8	3	—	—	11	55	16	1	—	72
		72·7	27·3	—	—	100·0	76·4	22·2	1·4	—	100·0
6 months and under 12.	Under 60	—	1	—	—	1	21	2	—	—	23
		—	8·3	—	—	8·3	18·9	1·8	—	—	20·7
	60—70	6	—	—	—	6	18	5	1	—	24
		50·0	—	—	—	50·0	16·2	4·5	0·9	—	21·6
	70—80	4	1	—	—	5	32	13	6	1	52
		33·3	8·3	—	—	41·7	28·8	11·7	5·4	0·9	46·8
	80—90	—	—	—	—	—	11	1	—	—	12
		—	—	—	—	—	9·9	0·9	—	—	10·8
		10	2	—	—	12	82	21	7	1	111
		83·3	16·7	—	—	100·0	73·9	18·9	6·3	0·9	100·0
12 months or since commencement of War.	Under 60	8	—	—	—	8	24	1	1	—	26
		23·5	—	—	—	23·5	24·7	1·0	1·0	—	26·8
	60—70	15	4	—	—	19	18	6	6	—	20
		44·1	11·8	—	—	55·9	18·6	6·2	6·2	—	30·9
	70—80	6	1	—	—	7	15	13	1	1	30
		17·7	2·9	—	—	20·6	15·5	13·4	1·0	1·0	30·9
	80—90	—	—	—	—	—	11	—	—	—	11
		—	—	—	—	—	11·3	—	—	—	11·3
		29	5	—	—	34	68	20	8	1	97
		85·3	14·7	—	—	100·0	701	20·6	8·3	1·0	100·0
Before the War.	Under 60	62	16	—	—	78	121	22	7	1	151
		30·7	7·9	—	—	38·6	31·1	5·7	1·8	0·3	38·9
	60—70	57	13	—	—	70	70	18	14	—	102
		28·2	6·4	—	—	34·6	18·0	4·6	3·6	—	26·2
	70—80	50	2	1	1	54	87	11	—	—	98
		24·8	1·0	0·5	0·5	26·7	22·4	2·8	—	—	25·2
	80—90	—	—	—	—	—	35	—	—	—	35
		—	—	—	—	—	9·0	—	—	—	9·0
	90	—	—	—	—	—	1	—	—	—	1
		—	—	—	—	—	0·3	—	—	—	0·3
	100	—	—	—	—	—	2	—	—	—	2
		—	—	—	—	—	0·5	—	—	—	0·5
		169	31	1	1	202	316	51	21	1	389
		83·7	15·3	0·5	0·5	100·0	81·3	13·1	5·4	0·3	100·0
		216	41	1	1	259	521	108	37	3	669
		83·4	15·8	0·4	0·4	100·0	77·9	16·1	5·6	0·4	100·0

Factories: Duration of employment, net of work, standard of physique.

D—bad. The heavy figures below the actual totals indicate percentages.

Medium.					Light.					Net average hours worked weekly.	Duration of Employment.
A	B	C	D	Total.	A	B	C	D	Total.		
—	1	—	—	1	18	1	—	—	19	Under 60	
—	3·1	—	—	3·1	51·4	2·9	—	—	54·3		
7	5	4	—	16	8	1	—	—	9	60—70	
21·9	15·6	12·5	—	50·0	22·9	2·9	—	—	25·7		Under
7	7	—	—	14	5	2	—	—	7	70—80	6 months.
21·9	21·9	—	—	43·8	14·3	5·7	—	—	20·0		
1	—	—	—	1	—	—	—	—	—	80—90	
3·1	—	—	—	3·1	—	—	—	—	—		
15	13	4	—	32	31	4	—	—	35		
46·9	40·6	12·5	—	100·0	88·6	11·4	—	—	100·0		
3	3	—	—	6	20	5	—	—	25	Under 60	
9·1	9·1	—	—	18·2	30·8	7·7	—	—	38·5		
11	1	1	—	13	19	1	—	—	20	60—70	
33·3	3·0	3·0	—	39·4	29.2	1·5	—	—	30·8		6 months
8	2	1	—	11	13	5	1	—	19	70—80	and
24·2	6·1	3·0	—	33·3	20·0	7·7	1·5	—	29·2		under 12.
3	—	—	—	3	—	1	—	—	1	80—90	
9·1	—	—	—	9·1	—	1·5	—	—	1·5		
25	6	2	—	33	52	12	1	—	65		
75·7	18·2	6·1	—	100·0	80·0	18·5	1·5	—	100·0		
3	3	1	—	7	37	7	4	—	48	Under 60	
6·5	6·5	2·2	—	15·2	50·0	9·5	5·4	—	64·9		
15	2	2	1	20	15	3	1	—	19	60—70	12 months
32·6	4·3	4·3	2·2	43·5	20·3	4·1	1·4	—	25·7		or since
16	2	—	—	18	—	5	1	—	6	70—80	commencement
34·8	4·3	—	—	39·1	—	6·8	1·3	—	8·1		of War.
1	—	—	—	1	1	—	—	—	1	80—90	
2·2	—	—	—	2·2	1·3	—	—	—	1·3		
35	7	3	1	46	53	15	6	—	74		
76·1	15·2	6·5	2·2	100·0	71·6	20·3	8·1	—	100·0		
11	2	2	1	16	48	8	7	—	63	Under 60	
8·2	1·5	1·5	0·7	11·9	24·5	4·1	3·6	—	32·2		
26	8	—	—	34	48	11	3	—	62	60—70	
19·4	6·0	—	—	25·4	24·5	5·6	1·5	—	31·6		
59	9	2	—	70	44	20	6	—	70	70—80	
44·0	6·7	1·5	—	52·2	22·4	10·2	3·1	—	35·7		Before the
12	—	—	—	12	—	—	1	—	1	80—90	War.
9·0	—	—	—	9·0	—	—	0·5	—	0·5		
2	—	—	—	2	—	—	—	—	—	90	
1.5	—	—	—	1·5	—	—	—	—	—		
—	—	—	—	—	—	—	—	—	—	100	
—	—	—	—	—	—	—	—	—	—		
110	19	4	1	134	140	39	17	—	196		
82·1	14·2	3·0	0·7	100·0	71·4	19·9	8·7	—	100·0		
185	45	13	2	245	276	70	24	—	370		
75·5	18·4	5·3	0·8	100·0	74·6	18·9	6·5	—	100·0		

Table 2. Number of Boys (under 18 years) examined in net average hours worked weekly,

General Health. A—good. B—slightly below normal. C—much below

Duration of Employment.	Net average hours worked weekly.	Very heavy process.			Heavy.				
		A	B	Total.	A	B	C	D	Total.
Under 6 months.	Under 50	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—
	Under 60	5	—	5	42	1	—	—	43
		83·3	—	83·3	67·8	1·6	—	—	69·4
	60—70	—	—	—	14	2	—	—	16
		—	—	—	22·6	3·2	—	—	25·8
	70—80	1	—	1	2	1	—	—	3
		16·7	—	16·7	3·2	1·6	—	—	4·8
		6	—	6	58	4	—	—	62
		100·0	—	100·0	93·5	6·5	—	—	100·0
6 months and under 12.	Under 50	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—
	Under 60	5	—	5	45	3	—	—	48
		100·0	—	100·0	63·4	4·2	—	—	67·6
	60—70	—	—	—	18	—	—	—	18
		—	—	—	25·4	—	—	—	25·4
	70—80	—	—	—	2	2	—	—	4
		—	—	—	2·8	2·8	—	—	5·6
	80—90	—	—	—	1	—	—	—	1
		—	—	—	1·4	—	—	—	1·4
		5	—	5	66	5	—	—	71
		100·0	—	100·0	93·0	7·0	—	—	100·0
12 months or since commencement of War.	Under 60	1	—	1	58	4	1	—	63
		33·3	—	33·3	72·5	5·0	1·3	—	78·7
	60—70	—	1	1	15	1	—	—	16
		—	33·3	33·3	18·7	1·3	—	—	20·0
	70—80	1	—	1	1	—	—	—	1
		33·3	—	33·3	1·3	—	—	—	1·3
		2	1	3	74	5	1	—	80
		66·7	33·3	100·0	92·5	6·3	1·3	—	100·0
Before the War.	Under 50	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—
	Under 60	2	—	2	27	3	—	—	30
		50·0	—	50·0	77·2	8·6	—	—	85·7
	60—70	1	—	1	4	1	—	—	5
		25 0	—	25·0	11·4	2·9	—	—	14·3
	70—80	1	—	1	—	—	—	—	—
		25·0	—	25·0	—	—	—	—	—
		4	—	4	31	4	—	—	35
		100·0	—	100·0	88·6	11·4	—	—	100·0
		17	1	18	229	18	1	—	248
		94·4	5·6	100·0	92·3	7·3	0·4	—	100·0

certain Munition Factories: Duration of Employment, heaviness of work, standard of physique.

normal. D—bad. The heavy figures below the actual totals indicate percentages.

Medium.					Light.					Net average hours worked weekly.	Duration of Employment.
A	B	C	D	Total.	A	B	C	D	Total.		
—	—	—	—	—	3	—	—	—	3	Under 50	
—	—	—	—	—	1·0	—	—	—	1·0		
11	1	—	—	12	68	2	1	1	72	Under 60	
4·8	0·4	—	—	5·3	21·7	0·6	0·3	0·3	23·0		Under
190	13	3	1	207	228	10	—	—	238	60—70	6 months.
83·7	5·8	1·3	0·4	91·2	72·8	3·2	—	—	76·0		
5·0	3	—	—	8	—	—	—	—	—	70—80	
2·2	1·3	—	—	3·5	—	—	—	—	—		
206	17	3	1	227	299	12	1	1	313		
90·8	7·5	1·3	0·4	100·0	95·6	3·8	0·3	0·3	100·0		
1	—	—	—	1	1	—	—	—	1	Under 50	
0·5	—	—	—	0·5	0·7	—	—	—	0·7		
11	1	—	—	12	39	2	—	—	41	Under 60	
5·0	0·5	—	—	5·5	27·3	1·4	—	—	28·7		6 months
175	21	2	—	198	92	7	2	—	101	60—70	and
80·3	9·6	0·9	—	90·8	64·3	4·9	1·4	—	70·6		under 12.
6	1	—	—	7	—	—	—	—	—	70—80	
2·8	0·5	—	—	3·2	—	—	—	—	—		
—	—	—	—	—	—	—	—	—	—	80—90	
—	—	—	—	—	—	—	—	—	—		
193	23	2	—	218	132	9	2	—	143		
83·5	10·6	0·9	—	100·0	92·3	6·3	1·4	—	100·0		
4	1	—	—	5	11	2	1	1	15	Under 60	
2·0	0·5	—	—	2·4	16·7	3·0	1·5	1·5	22·7		
171	27	2	—	200	46	4	—	—	50	60—70	12 months
83·4	13·2	1·0	—	97·6	69·7	6·1	—	—	75·8		or since
—	—	—	—	—	—	1	—	—	1	70—80	commencement
—	—	—	—	—	—	1·5	—	—	1·5		of War.
175	28	2	—	205	57	7	1	1	66		
85·4	13·7	1·0	—	100·0	86·4	10·6	1·5	1·5	100·0		
1	—	—	—	1	—	—	—	—	—	Under 50	
2·5	—	—	—	2·5	—	—	—	—	—		
5	—	—	—	5	6	—	—	—	6	Under 60	
12·5	—	—	—	12·5	19·4	—	—	—	19·4		
30	3	—	—	33	23	1	1	—	25	60—70	Before
75·0	7·5	—	—	82·5	74 2	3·2	3·2	—	80·6		the War.
1	—	—	—	1	—	—	—	—	—	70—80	
2·5	—	—	—	2·5	—	—	—	—	—		
37	3	—	—	40	29	1	1	—	31		
92·5	7·5	—	—	100·0	93 6	3·2	3·2	—	100·0		
611	71	7	1	690	517	29	5	2	553		
88·6	10·3	1·0	0·1	100·0	93·5	5·2	1·0	0·4	100·0		

MEN ENGAGED SINCE THE OUTBREAK OF WAR.

Table 3.—Very Heavy and Heavy Labour.

Hours of labour	General Health.		
	A	B+C+D	All groups.
Under 70 ...	150	40	190
Over 70 ...	102	45	147
All hours ...	252	85	337

Percentage of A's in "under 70" group 78·95
" " "over 70" " 69·39
Difference — 9·56 ± 3·22.

Table 4.—Medium and Light Labour.

Hours of labour	General Health.		
	A	B+C+D	All groups.
Under 70 ...	156	47	203
Over 70 ...	55	27	82
All hours ...	211	74	285

Percentage of A's in "under 70" group 76·8
" " "over 70" " 67·1
Difference — 9·7 ± 3·87.

Table 7.—Very Heavy and Heavy Labour.

Period of employment	General Health.		
	A	B+C+D	All groups.
Under 12 months	155	51	206
Over 12 months	97	34	131
All periods ...	252	85	337

Percentage of A's in "under 12 months" group 75·2
" " "over 12 months" " 74·0
Difference — 1·2 ± 3·30.

Table 8.—Very Heavy and Heavy Labour.

Period of employment	Hours of labour.		
	Under 70 hours.	Over 70 hours.	All hours.
Under 12 months	107	99	206
Over 12 months	83	48	131
All periods ...	190	147	337

Percentage of men working "under 70 and under 12 months" 51·9
Percentage of men working "under 70 and over 12 months" 63·4
Difference + 12·5 ± 3·74.

Table 9.—Medium and Light Labour.

Period of employment	General Health.		
	A	B+C+D	All groups.
Under 12 months	123	42	165
Over 12 months	88	32	120
All periods ...	211	74	285

Percentage of A's in "under 12 months" group 74·5
" " "over 12 months" " 73·3
Difference — 1·2 ± 3·55.

BOYS ENGAGED SINCE THE OUTBREAK OF WAR.

Table 5.—Very Heavy and Heavy Labour.

Hours of labour	General Health.		
	A	B+C+D	All groups.
Under 60 ...	156	9	165
Over 60 ...	55	7	62
All hours ...	211	16	227

Percentage of A's in "under 60" group 94·55
" " "over 60" " 88·71
Difference — 5·86 ± 2·57.

Table 6.—Medium and Light Labour.

Hours of labour	General Health.		
	A	B+C+D	All groups.
Under 60 ...	149	13	162
Over 60 ...	913	97	1,010
	1,062	110	1,172

Percentage of A's in "under 60" group 91·98
" " "over 60" " 90·40
Difference — 1·58 ± 1·67.

Table 11.—Very Heavy and Heavy Labour.

Period of employment	General Health.		
	A	B+C+D	All groups.
Under 12 months	135	9	144
Over 12 months	76	7	83
All periods ...	211	16	227

Percentage of A's in "under 12 months" group 93·8
" " "over 12 months" " 91·6
Difference — 2·2 ± 2·38.

Table 12.—Very Heavy and Heavy Labour.

Period of employment	Hours of labour.		
	Under 60 hours.	Over 60 hours.	All hours.
Under 12 months	101	43	144
Over 12 months	64	19	83
All periods ...	165	62	227

Percentage of boys working "under 60 hours and under 12 months" 70·1
Percentage of boys working "under 60 hours and over 12 months" 77·1
Difference + 7·0 ± 4·14.

Table 13.—Medium and Light Labour.

Period of employment	General Health.		
	A	B+C+D	All groups.
Under 12 months	830	71	901
Over 12 months	232	39	271
All periods ...	1,062	110	1,172

Percentage of A's in "under 12 months" group 92·1
" " "over 12 months" " 85·6
Difference — 6·5 ± 1·36.

MEN ENGAGED SINCE THE OUTBREAK OF WAR.

Table 10.—Medium and Light Labour.

Period of employment	Hours of Labour. Under 70 hours.	Over 70 hours.	All hours.
Under 12 months	109	56	165
Over 12 months	94	26	120
All periods ...	203	82	285

Percentage of men working "under 70 hours and under 12 months," 66·1
Percentage of men working "under 70 hours and over 12 months," 78·3
Difference + 12·2 ± 3·66.

Table 15.—Heavy Labour.
Length of Employment, 6—12 Months.

Hours of labour	General Health. A	B+C+D	All groups.
Over 70 hours	39	8	47
Under 70 hours	43	21	64
All hours ...	82	29	111

Percentage of A's in "under 70 hours" group 83·0
" " " "over 70 hours" " 67·2
Difference — 15·8 ± 5·69.

Table 16.—Heavy Labour. Length of Employment, 12 Months—2 Years.

Hours of labour	General Health. A	B+C+D	All groups.
Under 70 hours	42	14	56
Over 70 hours	26	15	41
All hours ...	68	29	97

Percentage of A's in "under 70 hours" group 75·0
" " " "over 70 hours" " 63·4
Difference — 11·6 ± 6·35.

MEN ENGAGED BEFORE THE WAR.

Table 19.—Very Heavy and Heavy Labour.

Hours of labour	General Health. A	B+C+D	All groups.
Under 70 ...	310	91	401
Over 70 ...	175	15	190
All hours ...	485	106	591

Percentage of A's in "under 70" group 77·31
" " "over 70" " 89·74
Difference + 12·43 ± 2·28.

Table 20.—Medium and Light Work.

Hours of labour	General Health. A	B+C+D	All groups.
Under 70 ...	133	42	175
Over 70 ...	117	38	155
All hours ...	250	80	330

Percentage of A's in "under 70" group 76·00
" " "over 70" " 75·48
Difference — 0·52 ± 3·19.

BOYS ENGAGED SINCE THE OUTBREAK OF WAR.

Table 14.—Medium and Light Labour.

Period of employment	Hours of Labour. Under 60 hours.	Over 60 hours.	All hours.
Under 12 months	142	759	901
Over 12 months	20	251	271
All periods ...	162	1,010	1,172

Percentage of boys working "under 60 hours and under 12 months," 15·8
Percentage of boys working "under 60 hours and over 12 months," 7·4
Difference — 8·4 ± 1·61.

Table 17.—Medium and Light Labour.
Length of Employment under 6 Months.

Hours of labour	General Health. A	B+C+D	All groups.
Under 60 ...	82	5	87
Over 60 ...	428	30	458
All hours ...	510	35	545

Percentage of A's in "under 60 hours" group 94·3
" " " "over 60 hours" " 93·4
Difference — ·9 ± 1·93.

Table 18.—Medium and Light Labour. Length of Employment, over 6 Months.

Hours of labour	General Health. A	B+C+D	All groups.
Under 60 ...	52	3	55
Over 60 ...	273	33	306
All hours ...	325	36	361

Percentage of A's in "under 60 hours" group 94·5
" " " "over 60 hours" " 89·2
Difference — 5·3 ± 2·96.

BOYS ENGAGED BEFORE THE WAR.

Table 21.—Very Heavy and Heavy Labour.

Hours of labour	General Health. A	B+C+D	All groups.
Under 60 ...	29	3	32
Over 60 ...	6	1	7
All hours ...	35	4	39

Percentage of A's in "under 60" group 90·63
" " "over 60" " 85·71
Difference — 4·92 ± 8·54.

Table 22.—Medium and Light Labour.

Hours of labour	General Health. A	B+C+D	All groups.
Under 60 ...	12	0	12
Over 60 ...	54	5	59
All hours ...	66	5	71

Percentage of A's in "under 60" group 100·00
" " "over 60" " 91·52
Difference — 8·48 ± 5·46.

It is then probably permissable to draw from the data the conclusion that long hours seem to exercise a prejudicial effect upon average general health. The exact intensity of this effect cannot, of course, be measured by data of this kind, but if we combine all the results for post-war men it appears that 22·1 per cent. of the men working less than 70 hours are in a physical class below A, and 31·4 per cent. of those working 70 or more hours. Of the boys 6·7 per cent. and 10·6 per cent. respectively are the percentages amongst those working less than 60 hours, and for those working 60 hours or more. This difference is a serious one.

If one examines the *relations between health and nature of work*, it appears that the heavier grades of work are associated on the whole with a higher health standard. Taking all the men together, the proportion of A men is 83%, 78%, 76% and 75% in the very heavy, heavy, medium and light occupations respectively, and this relation holds for both pre-war and post-war workers. The heavier work may actually be healthier, though the suggestion of selection is strong.

The influence of change of occupation is interesting. Out of the total numbers examined, adult and juvenile, who had been employed not less than six months, it was found that 887 persons had vacated other occupations to go into munition factories. Twenty-nine of this number reported themselves as feeling better, the result of increased wages, regular hours and improved factory environment in contrast to the conditions of their former avocations, such as underground offices or workshops and exposure to dust in tea-packing, flour mills and other industries. The majority, 741, reported that they felt just the same, whilst 117 complained of feeling worse. The previous occupations included barmen, silversmiths, auctioneers, commercial travellers, farmers, bakers, butchers, grocers, stablemen, dental mechanics, coachmakers, goldbeaters, valets, tailors, bricklayers, shoemakers, horsehair cleaners, shop assistants and clerks, amongst many others. Further interest is lent to this part of the inquiry on account of the determination of many of these workers to turn their backs on their former occupations; and especially in reference to barmen, who, in every case, reported a very marked improvement in health, which was ascribed to greater regularity of meal hours and abstinence from "nipping," with consequent improved appetite.

MEDICAL DEFECTS FOUND.

11. Table 23 shows the predominant physical disabilities of the workers, adult and juvenile; some of them contribute, perhaps in a slight measure, to fatigue, or are the result of overwork. In the earlier part of this inquiry, I did not recognise sufficiently the value of every particle of evidence bearing upon the question of general health and overwork, so that some of the items do not appear throughout the list. In other cases where percentages are small, they have been marked down because, at the time of examination, the evidences were so clearly marked in the examinees.

In *Factory* 1 (work of all grades of severity) men were examined at a season of the year when the weather was very bad. Most of them were working long hours and many of them had to travel long distances to and from their work. The nervous symptoms were marked, especially in the case of the boys. Amongst the latter the percentage record showed less than the truth, as a note was made only in those cases who were suffering severely. Sleepiness on the night shift showed large percentages which were due, particularly among the boys, to the evils of night shifts. Without discussing the reasons for and against night shifts, the fact remained that the figures, as they stand, admit of very little argument. The workers were genuinely tired, and I frequently found that the boys never became accustomed to the conditions of a night shift owing to the frequency of the change over; in other words when a boy at the end of a week of day work is just recovering from the effects of night shift he is back again on to night work. Restlessness, as recorded here, was very severe, and was due, in all cases, so it was reported, to the struggles for trams and trains and the long journeys homewards after the day's toil. Headache, in the case of the men, was very largely due to digestive disturbances, but in the case of the boys was the result of shop conditions, loss of sleep, long hours of work and long journeys to and from the factory. Muscular pains were noted at this time only in the case of those who were suffering severely. The figures for the teeth do not need discussion. In the case of eyesight, the percentage of spectacles recorded for this and other factories includes, for the most part, those men who, either in the gas light or for the purposes of reading, were forced to wear spectacles owing to the changes which take place in the eyes about middle life. The majority of processes upon which the men examined were engaged did not call for the use of spectacles. Under the head of "corrected," the figures represent men or boys who had defective sight, had had their defects corrected, and were ordered to wear spectacles continuously. Skin rashes resulting from exposure to oils used as lubricants at this factory equal 9%, and were due, in a very large measure, so I was informed, to want of proper cleanliness—in my opinion the direct result of imperfect facilities for washing.

In *Factory* 2 (work mostly very heavy, heavy and medium) digestive and respiratory troubles were high, the respiratory troubles because at the season of the year at which this factory was visited the weather was extremely bad. The percentages for nervous symptoms are low. There was no record of particular men being unduly tired either at the end of the day or on rising in the morning. This had been largely brought about by the reduction of hours which had taken place on three or four occasions. Sleepiness on the night shift was not very common, particularly amongst the boys. The majority of boys in this factory came from good homes, and showed a striking contrast after the conditions reported in Factory 1. Headache was common amongst the boys, and was due to the noise of the machinery and the smell of oil rather than to loss of sleep. Digestive disturbances were similarly caused. It was ascertained, in the course of this inquiry, that most of the boys at this factory slept alone (*see* para. 24). Muscular pains are more numerous than in Factory 1, but that was due, very largely, to closer inquiry and greater appreciation of their value for this report. In any case they are caused by standing for long periods at machines or benches. Nasal catarrh was severe. The condition of the teeth calls for note: the majority of the boys had very good teeth, but oral sepsis was considerable and, in many cases, severe.

In *Factory* 3 (work mostly very heavy and heavy) the digestive disturbances among the men were high, probably owing to the prevalence of very bad teeth. Respiratory troubles were also high because the weather was very cold and the majority of the men were engaged in hot and heavy trades. The percentage of nervous affections was small. Overwork as measured by a tiredness either at the end of the day or on rising in the morning was not noted. A large number of boys in this factory complained of sleepiness on the night shift. The percentage of men suffering from restlessness on going to bed was small, and was due, almost entirely, to the discomfort of varicose veins aggravated by their heavy work and their exposure to furnace fires, &c. The percentage of men suffering from headache was high. Footache and muscular pains together form a high percentage in both men and boys. The importance of these symptoms is obvious, and their contribution to strain from fatigue is very considerable and must be regarded as an index of the workers' health conditions. Enlarged tonsils were very prevalent among the boys, and I have no doubt caused the boys to resist more feebly the strain of their work. For the most part the teeth of the boys were good, but there was a sad neglect of oral cleanliness.

In *Factory* 4 (work heavy and medium) digestive troubles were numerous amongst the men as well as amongst the boys. Many of the boys in this and succeeding Factories 5 and 6, where steel is made, suffered severely from digestive troubles owing to the irregularity with which they take their meals, many of them having to "work through" on account of the "heats." Respiratory troubles were not so high, because the weather had improved considerably. A definite record of the nervous conditions of the men and of the boys was difficult to obtain here owing to the fact that the employees were afraid of the information being conveyed to the management, though it was distinctly pointed out to them that any information they chose to give was confidential. On the night shift, 20% of the boys suffered from marked sleepiness and weariness due, in large measure, to the monotony of the work, the peculiar character of the work and the juvenility of the workers; 11% of the men suffered from restlessness on retiring to bed, due to the weariness produced by long hours of work. Footache, muscular pains and swelling feet were very prevalent. In this factory the men and the boys were very poor specimens compared with those examined in the preceding works. This was due entirely to the peculiarities of the industry. As usual, oral sepsis existed, but to a greater extent than in any other factory visited; 9·8% of the men engaged here suffered from deafness, the cause for which could not be ascertained.

In *Factory* 5 (work mostly very heavy and heavy) the percentages for digestive troubles are high, due to a variety of causes, chief amongst which are the condition of the teeth and the irregularity of meal hours, owing to the nature of the work. The number of employees, both adult and juvenile, complaining of weariness at various periods of the week is about average. On the night shift a very large percentage of the boys complain of sleepiness. At the time of the examination, those amongst whom this complaint was made were quite young and doing very heavy work on a 12-hour night shift, exposed to excessively high temperatures in stamping and shell shops, and with very little opportunity for sufficient rest owing to many causes, chief of which, perhaps, was the domestic conditions of their homes. Headache was prevalent. The percentage of footache amongst these boys was not so high as in the preceding factory, but was severe. Muscular pains were frequent and occurred generally amongst the boys just over 14 years of age. Enlarged tonsils again were very prevalent. The teeth here were, amongst the majority, very good, but again sadly neglected. Defective eyesight, both amongst boys and men, was not numerous. Among the men, headache of a frontal character was common. Footache and muscular pains were very prevalent and in many cases very severe, brought about by reason of their heavy work and exposure to high temperatures.

In *Factory* 6 (work mostly very heavy and heavy) the percentages of workers suffering from digestive troubles are again high. Many men complain of weariness at the week-end, ascribed by them to their work and also to shop conditions, which would, in my opinion, contribute very largely to such an end. The sand about the foundry floors is hot, and in the establishments under review all the men working in the foundries complain. The factory is old, and the shop arrangements, generally speaking, are not good. The fettlers particularly were affected by weariness both night and morning, but men engaged in other branches of industry fall within this category. There is no record for boys with reference to sleepiness on the night shift because the majority of boys examined did not work on night shift. Headache amongst the men was frequent and severe: amongst the boys the percentage was very low. Flat foot, footache, swelling feet and muscular pains were severe and frequent. Amongst the boys these defects did not show such a high percentage as amongst similar boys in other factories of the same town. Enlarged tonsils were again very frequent. Deafness amongst boys and men is referred to, the deafness occurring chiefly amongst those engaged in foundries.

Factory 7 (work heavy and medium) had been running for about six months prior to the examination conducted on behalf of your Committee. It is in a town quite unaccustomed to the conditions common to munition workers. The weather at the time of the examination was very good. Respiratory troubles are referred to as being found amongst 13% of the workers. One-third of the men complained of being thoroughly tired at the end of the day; 13% of the boys reported similarly. The work was heavy, chiefly pressing 6-inch shells, and the unaccustomed conditions of the work account very materially for these figures. On the night shift 11% of the men and 20% of the boys complained of being very sleepy. During the afternoon 7% of the men complained of sleepiness and weariness due to exposure to high temperatures and the heavy work; 9% of the men complained of restlessness at night, reporting that they felt too tired after their day's work to sleep when they get into bed. Footache was very prevalent amongst the men; muscular pains were complained of by 31%. Amongst the boys, swelling feet were not uncommon, and inquiry elicited the information that the swelling had only made its appearance since they had worked close to the shell furnaces. Enlarged tonsils were frequent, the eyesight was good, and the teeth very moderately good.

Factory 8 (work medium and light) was a modern factory employing a large number of men. For the purposes of the inquiry, I examined all the boys available with the results set out in the table. The number complaining of tiredness was rather small and due, in the majority of cases, to the fact that the boys had very recently left school and joined the factory. The

TABLE 23.—A table of physical defects to show the comparison between the Factories and also

—	Factory 1. Feb.—March.		Factory 2. March—April.		Factory 3. April—May.		Factory 4. May.	
	Men, 532.	Boys, 88.	Men, 376.	Boys, 124.	Men, 137.	Boys, 73.	Men, 61.	Boys, 29.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
General health grouping, A	74·5	69·3	76·9	90·3	85·4	93·1	75·4	75·8
General health grouping, B	17·7	26·2	17·8	6·5	12·4	6·9	21·3	17·2
General health grouping, C	7·1	4·5	5·1	1·6	2·2	—	3·3	7·0
General health grouping, D	0·7	—	0·2	1·6	—	—	—	—
Digestive	3·4	—	26·0	—	42·3	6·8	34·5	13·7
Constipation	1·5	—	—	1·6	6·5	8·2	5·0	—
Circulatory	2·0	1·1	1·3	—	2·8	—	6·6	3·4
Respiratory	5·5	—	45·5	16·1	51·0	34·2	39·3	3·4
Nervous	10·5	13·6	4·5	2·5	3·6	—	1·6	—
Tired, end of day	—	—	1·1	—	—	—	—	3·4
„ week-end	—	—	0·5	—	—	—	—	—
„ rising	—	—	—	—	—	—	—	—
Easily fatigued	18·5	13·6	0·2	0·2	—	—	—	—
Sleepiness :—								
Night shift	25·0	41·0	2·7	1·6	0·7	15·5	—	20·7
Afternoons	—	—	—	—	—	—	—	—
Restless	10·7	10·2	2·1	0·8	3·0	1·4	11·0	—
Headache—								
Frontal	16·7	33·0	15·9	22·5	18·2	22·0	26·2	20·7
Temporal	2·0	—	2·9	1·6	0·7	1·4	3·2	3·4
Occipital	1·3	—	1·3	0·8	1·4	—	3·2	—
Migraine	—	—	0·2	—	—	—	—	—
Anæmia	0·2	3·4	0·2	0·8	0·7	2·8	—	—
Fainting	0·6	—	0·5	—	—	—	—	—
Giddiness	—	—	0·2	3·2	0·7	1·4	—	—
Varicose veins	8·0	—	9·2	1·6	3·6	1·4	3·2	—
Hæmorrhoids	4·0	—	6·9	—	4·4	—	9·8	—
Flat foot	1·3	1·1	0·2	2·4	—	—	—	—
Footache	—	—	—	—	6·5	31·5	21·3	38·0
Swelling feet	3·5	1·1	8·5	—	4·4	2·8	8·2	—
Muscular pains	18·0	3·4	32·0	12·0	29·0	8·2	36·0	24·1
Hernia	8·3	—	7·9	—	4·4	—	5·0	—
Double	—	—	1·1	—	—	—	3·2	—
Ventral	—	—	0·2	—	0·7	—	—	—
Umbilical	—	—	—	—	—	—	—	—
Nasal catarrh	50·0	30·0	71·0	55·6	97·0	90·4	98·3	92·4
Enlarged tonsils	0·2	9·0	1·1	5·6	—	37·0	—	34·5
Cleft palate	—	—	0·2	—	—	—	—	—
Teeth :—								
Good	55·4	82·0	—	92·0	—	91·8	24·6	—
Moderately good	—	—	47·5	0·8	25·6	—	14·7	82·8
Very bad	32·0	14·0	35·4	6·4	52·6	8·2	47·2	17·2
None	2·0	—	7·6	—	10·9	—	6·5	—
False	9·0	4·0	9·5	0·8	10·9	—	7·0	—
Sepsis	—	—	61·7	29·8	71·5	51·0	82·0	65·5
Eyes-strain	—	6·8	—	—	—	—	—	—
Good	90·4	93·2	89·8	97·5	95·0	98·6	92·5	89·7
Defective	5·6	—	10·2	2·5	5·0	1·4	7·5	10·3
Corrected	—	—	3·2	2·5	—	—	—	3·4
Spectacles	38·0	—	25·5	2·5	46·0	—	42·6	—
Cataract	—	—	0·1	—	2·0	—	0·8	—
Glass eye	1·3	—	0·2	—	0·6	—	—	—
Deaf	—	—	0·2	—	—	1·4	9·8	—
Oil rash	—	9·0	—	—	—	—	—	—
Enlarged thyroid	—	—	—	—	—	—	—	—
Otitis media	—	—	—	—	—	—	—	—

showing various effects of "fatigue," and the season of the year when the enquiry was conducted.

Factory 5. May.		Factory 6. May—June.		Factory 7. June—July.		Factory 8. July.	Factory 1. July—August.
Men, 152.	Boys, 97.	Men, 240.	Boys, 91.	Men, 45.	Boys, 15.	Boys, 92.	Boys, 900.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
87·5	88·4	76·6	93·5	73·3	86·7	98·9	92·0
12·0	10·3	17·5	5·4	24·5	13·3	1·1	6·7
—	1·3	5·5	1·1	2·2	—	—	0·4
0·5	—	0·4	—	—	—	—	—
40·7	18·5	41·2	15·3	20·0	—	4·4	4.0
—	2·1	—	—	—	—	1·1	2·6
1·9	—	0·8	1·1	—	—	1·1	0·7
36·8	7·2	33·7	2·2	13·3	—	1·1	0·6
—	—	0·4	—	—	—	—	0·2
11·2	5·2	3·0	—	33·3	13·3	7·6	14·5
—	6·2	30·5	6·5	33·3	13·3	11·0	15·2
—	1·3	33·7	12·0	4·5	—	5·5	20·0
2·0	—	3·7	2·2	—	—	—	1·5
0·6	24·7	2·1	—	11·1	20·0	—	51·0
—	—	—	—	6·6	—	7·7 (if hot weather.)	—
3·3	—	6·2	2·2	8·8	—	—	3·0
19·7	28·8	25·0	6·2	8·8	—	17·5	15·0
3·2	2·6	1·3	4·4	—	—	4·3	1·6
2·0	—	0·4	3·3	—	—	1·1	1·1
2·0	3·1	0·4	2·2	—	—	—	0·9
—	—	0·4	—	—	—	—	2·2
—	—	0·8	—	—	—	—	—
—	—	0·8	—	—	—	—	0·1
4·5	—	8·0	—	8·8	—	—	—
6·5	—	2·1	—	—	—	—	—
—	—	0·4	2·2	—	—	1·1	0·1
46·0	16·5	45·0	7·7	24·4	6·6	6·5	14·5
8·5	2·6	3·8	2·2	4·4	13·3	1·1	—
39·5	15·4	32·5	9·8	31·1	6·6	7·6	17·0
7·2	—	6·2	—	8·8	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
0·6	—	—	—	—	—	—	—
92·1	99·0	96·2	98·5	97·5	53·3	24·0	82·5
—	35·0	—	33·3	—	13·3	24·0	19·2
—	—	—	—	—	—	—	0·1
20·3	92·8	10·5	86·8	13·5	86·6	66·3	73·6
18·5	4·1	26·6	11·0	22·2	6·6	25·0	24·1
39·5	3·1	43·7	2·2	46·6	6·8	3·3	2·3
16·3	—	10·0	—	11·1	—	—	—
5·3	—	9·2	—	6·6	—	5·4	—
77·5	63·1	55·5	48·3	77·7	53·3	17·4	—
—	—	—	—	—	—	—	—
92·2	97·9	88·0	94·5	97·7	100·0	98·9	97·8
7·8	2·1	12·0	5·5	2·3	—	1·1	2·2
—	—	—	—	—	—	1·1	—
65·5	—	53·0	—	42·2	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	1·3	8·3	2·2	4·5	—	1·1	0·3
—	—	—	—	—	—	—	0·8
—	—	—	—	—	—	—	0·2
—	—	—	—	—	—	—	0·1

general condition of the boys was excellent, and the home conditions, broadly speaking, were very good. There was not much incentive to be out later than 10 o'clock in this particular town owing to the lighting regulations. There were complaints of sleepiness in the afternoons in hot weather. This was ascribed to the warmth of the workshop and the peculiarly soporific atmosphere of the district. Headache was frequent. Flat foot, footache and muscular pains were not severe and were not frequent. Nasal catarrh and enlarged tonsils were common. The cleanliness of the mouth was marked.

At the time of the return visit to *Factory* 1 the weather was exceedingly good. The percentages of boys complaining of tiredness at varying periods of the week are interesting. In some cases it was undoubtedly due to the prevalence of late hours, but not in all cases. In my opinion the majority of boys so complaining did so because they were tired as the result of really hard work, frequently combined with the difficulties of a long railway or tram journey. Sleepiness on the night shift claims 51% of the workers. It may be said that this was largely due to the neglect of opportunities for sleep during the day. It might be suggested that though the boy is tired and goes to bed immediately he leaves the night shift, he not infrequently gets up early in the afternoon so as to obtain some social amusement before going to work. In my opinion this may account for a small percentage of the sleepiness that I found amongst these boys, but I do not feel satisfied on the point. The boys in this factory work alternate day and night shifts of 12 hours, in many cases stand for hours when travelling to and from their homes, and very frequently when they reach home have to wait some little time for a meal before they get to bed. Generally, I found that where the domestic conditions were good, and there was little doubt about the authenticity of the statements with reference to hours of sleep, the boys still complained of sleepiness. It is contrary to the laws of nature for young children—for such many of these are—to be able to turn night into day without feeling an effect. Amongst the boys examined in the various departments of this factory on this occasion many complained of footache and muscular pains though they were not exposed to temperatures other than the ordinary temperature of a workshop. Nasal catarrh was very prevalent, enlarged tonsils also. The teeth were, for the most part, good, but there was a great lack of oral cleanliness.

CONSIDERATIONS ARISING FROM THE NATURE OF THE WORK.

12. (*a*) *In the very heavy trades* nearly all the men complained of feeling thoroughly tired and weary at the end of their day's work where the shift was more than eight hours. The rarity of the 8-hour shift in these trades struck me as remarkable (*see* below). In the few instances where I examined men working for such periods, they nearly always reported that they felt at the end of the shift almost as well as when starting work. Amongst the steel smelters and the other very heavy trades, an effort is made by the workmen to overcome the defects of the 12-hour shift. They arrange between themselves to shorten the day shift and lengthen the night shift. As these are alternate, the men so engaged have the opportunity of enjoying more recreation and rest every other week. In all very heavy trades which I have investigated, the exposure to heat is considerable, and renders physical effort more exhausting. In two factories where steel was made by the open hearth method, the men so engaged gave one the impression of being a good sample, due very largely, in my opinion, to the excellence of the general arrangements, which permitted them to get modern plants at such works and the opportunity for getting away from the immediate vicinity of the furnaces, whilst still near enough to regulate them. At one factory where the shop conditions are undoubtedly very bad, owing to lack of ventilation, old-fashioned methods of charging the furnaces, and the general proximity of the furnaces to each other, the men gave the impression of showing signs of being weary and tired. They were sallow complexioned, looked more tired, and certainly had not the physique of men similarly engaged in the better workshops. The temperature of this steel shop at the time of my visit was 138° Fahr., the temperature of the teemings varying from 1,800 to 2,300 degrees Centigrade. I had the opportunity of reviewing the men on the day shift as well as those who worked on the night shift, and they all complained of the imperfect ventilation and the want of proper machinery with which to charge the furnaces. The forgemen engaged on the heavy ingots used for making big guns appeared strong, well-nourished, powerful men. At the time of this examination their hours were long, and it was only owing to the intermittent character of their work that they were able to stand up against the strain they were enduring. The shop manager said that in his opinion the men had worked magnificently, but would not be able to continue at the same pressure in spite of the intermittent conditions. This class of work causes the men to become very thirsty. For an onlooker, unaccustomed to industrial conditions such as these, the greatest sympathy for the workers is excited because the effort called for is tremendous, and the way these men perspire as a result of their heavy work and exposure to the furnaces is astonishing. Beer is the usual refreshment. A few of the workers are abstainers from alcohol in any form. These latter are usually the most reliable men. When the supply of drink was restricted by the closing of the public houses in the district, a great improvement in the health and the timekeeping of the workmen was noticed and was admitted by the men. No satisfactory substitute for beer, so far as is at present known, has been introduced. The use of such substitutes as oatmeal water and barley water is stated to cause skin eruptions and boils.

The work, though very hard, is usually intermittent with long periods of comparative rest. The weather greatly influences the capacity of the men for work; wind blowing the air over the hot furnaces into their faces adds considerably to their difficulties; really cold weather soon affects the older men by producing chest troubles and rheumatic conditions, though the younger and newer hands work with much greater comfort.

(*b*) In the *heavy trades*, almost with one consent the men tell you that at the end of the day they have had as much as they can possibly stand. In many instances these men, in order to do their work satisfactorily, absent themselves for a couple of days for rest purposes. I am assured by the firms that so long as the departmental managers know that these men are absent justifiably, no

TABLE 24A.—Loss of Time, through Illness or Accident, by Men (41 years or over) Examined in Certain Munition Factories; Cause, Standard of health, number affected, total time lost.

Standards of General Health :—A = good; B = slightly below normal; C = much below normal; D = bad.

Cause.	Group A (1,198 examined).			Group B (263 examined).			Group C (76 examined).			Group D (6 examined).			All groups (1,543 examined).		
	Men affected.		Time lost.	Men affected.		Time lost.	Men affected.		Time lost.	Men affected.		Time lost.	Men affected.		Time lost.
	No.	Percentage of number examined.		No.	Percentage of number examined.		No.	Percentage of number examined.		No.	Percentage of number examined.		No.	Percentage of number examined.	
			days.			days.			days.			days.			days.
Illness	301	25·3	4,910	105	40	3,396	41	53·9	1,929	3	50·0	105	450	29·2	10,340
A.—Special :—															
Digestive	38	3·2	685	17	6·5	508	6	7·9	44	2	33·3	56	63	4·1	1,293
Respiratory	148	12·4	1,514	29	11·0	516	13	17·1	596	—	—	—	190	12·3	2,626
Circulatory	1	0·1	35	4	1·5	140	5	6·6	292	—	—	—	10	0·6	467
Nervous { definite... ...	5	0·4	110	2	0·8	35	2	2·6	63	—	—	—	9	0·6	208
Nervous { indefinite ...	17	1·4	168	9	3·4	159	—	—	—	1	16·7	49	27	1·8	376
Urinary	2	0·2	63	1	0·4	105	—	—	—	—	—	—	3	0·2	168
Ocular	1	0·1	7	2	0·8	254	—	—	—	—	—	—	3	0·2	261
B.—General :—															
Rheumatism	55	4·6	1,729	29	11·0	1,229	15	19·7	934	—	—	—	99	6·4	3,892
Microbic and other infections	32	2·7	459	11	4·2	443	—	—	—	—	—	—	43	2·8	902
Miscellaneous	2	0·2	140	1	0·4	7	—	—	—	—	—	—	3	0·2	147
Accident	88	7·4	2,310	9	3·4	131	4	5·2	183	—	—	—	101	6·6	2,624
Injury to :—															
Head...	6	0·5	175	—	—	—	1	1·3	42	—	—	—	7	0·5	217
Eye	1	0·1	42	—	—	—	—	—	—	—	—	—	1	0·1	42
Arm	3	0·3	82	—	—	—	—	—	—	—	—	—	3	0·2	82
Hand	29	2·4	558	3	1·1	56	1	1·3	42	—	—	—	33	2·1	656
Body...	9	0·8	119	3	1·1	56	—	—	—	—	—	—	12	0·8	175
Leg	11	0·9	699	1	0·4	4	—	—	—	—	—	—	12	0·8	703
Foot	19	1·6	512	—	—	—	—	—	—	—	—	—	19	1·2	512
Miscellaneous	10	0·8	123	2	0·8	15	2	2·6	99	—	—	—	14	0·9	237
	389	32·7	7,220	114	43·4	3527	45	59·1	2,112	3	50·0	105	551	35·8	12,964

TABLE 24B.—Loss of time through illness or accident, by Boys (under 18 years) examined in certain Munition Factories; cause, standard of health, number affected, total time lost.

Standards of general health; A = good; B = slightly below normal; C = much below normal; D = bad.

Cause.	Group A (1,374 examined).			Group B (119 examined).			Group C (13 examined).			Group D (3 examined).			All Groups (1,509 examined).		
	Boys affected.		Time lost.	Boys affected.		Time lost.	Boys affected.		Time lost.	Boys affected.		Time lost.	Boys affected.		Time lost.
	No.	Percentage of number examined.		No.	Percentage of number examined.		No.	Percentage of number examined.		No.	Percentage of number examined.		No.	Percentage of number examined.	
			days			days			days			days			days
Illness	266	19·3	2,952	38	31·9	525	9	69·3	219	1	33·3	2	314	20·9	3,698
A.—Special:—															
Digestive	76	5·5	655	6	5·0	41	1	7·7	6	—	—	—	83	5·5	702
Respiratory	49	3·6	628	10	8·4	121	1	7·7	7	1	33·3	2	61	4·0	758
Circulatory	—	—	—	—	—	—	1	7·7	21	—	—	—	1	0·1	21
Nervous { definite... ...	21	1·5	107	5	4·2	71	—	—	—	—	—	—	26	1·7	178
Nervous { indefinite ...	37	2·7	149	6	5·0	44	2	15·4	11	—	—	—	45	3·0	204
Urinary	1	0·1	84	—	—	—	—	—	—	—	—	—	1	0·1	84
Ocular	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B.—General:—															
Rheumatism	7	0·5	128	4	3·4	140	2	15·4	112	—	—	—	13	0·9	380
Microbic and other infections	40	2·9	749	4	3·4	64	—	—	—	—	—	—	44	2·9	813
Miscellaneous	35	2·5	452	3	2·5	44	2	15·4	62	—	—	—	40	2·7	558
Accident	134	9·7	2,855	16	13·4	381	—	—	—	—	—	—	150	9·9	3,236
Injury to:—															
Head...	14	1·0	221	—	—	—	—	—	—	—	—	—	14	0·9	221
Eye	4	0·3	37	1	0·8	120	—	—	—	—	—	—	5	0·3	157
Arm	16	1·2	225	2	1·7	32	—	—	—	—	—	—	18	1·2	257
Hand	60	4·4	1,256	8	6·7	181	—	—	—	—	—	—	68	4·5	1,437
Body	6	0·4	179	—	—	—	—	—	—	—	—	—	6	0·4	179
Leg	14	1·0	660	2	1·7	17	—	—	—	—	—	—	16	1·1	677
Foot	13	0·9	178	2	1·7	24	—	—	—	—	—	—	15	1·0	202
Miscellaneous	7	0·5	99	1	0·8	7	—	—	—	—	—	—	8	0·5	106
	400	29·0	5,807	54	45·3	906	9	69·3	219	1	33·3	2	464	30·8	6,934

notice is taken. The effect upon the boys was commencing to show itself. Many, though little more than 14, were working 12-hour shifts, and doing heavy work. In the stamping shop, with an outside temperature of 78° Fahr., the inside temperature close to the gateway was 90° Fahr. In a smith shop the temperature was much higher, but varied according to one's proximity to the furnaces. The boys in these shops manipulate heavy pieces of steel at a temperature of about 900° Fahr. They struck me as being considerably overworked; they looked dull and spiritless, and conversation with them gave the impression that they were languid. In fact, all the boys in this group were working, in my opinion, far too hard.

(*c*) The physical fatigue of the *medium and light occupations* is not such that it produces a feeling of weariness and overwork of itself. Monotony and long hours added to weight of work are the chief causes. Amongst the men, the complaints concerning weight of work were not so frequent as concerning length of hours. Several of the men I examined complained about the continuous work without a break. Amongst the boys engaged in the occupations under discussion, complaints were made that they felt the long hours—in many instances with added difficulties of getting to and from home—but they said that owing to much better wages they thought they would be able to continue for at least some time. On the other hand many of the boys expressed themselves as desirous of returning to their old occupations, even though for lower wages. In these trades, both for men and boys, the effect of work and long hours is shown by the weariness and generally "fed-up" condition of the workers.

With reference to the table (23) dealing with the defects of the men engaged in the various factories, there is no one defect that points conclusively to overwork or strain, but many of the symptoms taken collectively indicate severe strain, and I would suggest that sleepiness on the night shift, headache, footache and muscular pains are probably the most common signs of overwork. The nervous symptoms added to these go far to complete the picture. The effect of noise upon the individual and its contribution to feelings of overtiredness and exhaustion must be considerable. In many of the workshops visited, though the work was not heavy, the noise was such that the result of lengthened periods in these factories was almost as severe as exposure to high temperature coupled with hard work.

HOURS OF LABOUR.

13. The hours of labour were found to vary considerably. In some cases for boys under 14 years of age they were limited to 48, but in others boys of 18 were found to be working an average of over 80 hours per week, and it was ascertained that they had worked 90 and even 100 hours per week. In the case of men, the net average hours ranged from 53 to 108 hours per week. The latter hours, I am glad to say, were not prevalent, but they are recorded in Tables 1 and 2. Hours of labour must be considered in relation to the distance many of the workers have to travel to and from their work. While engaged for 12 hours per day in the factory, they spend in a large number of cases from two and a half to four hours travelling to and from their homes. One boy, for example, travels 38 miles to and from his work, and spends four hours in transit. Another boy, aged 15, travels 26 miles to and from his work and spends four hours in the transit. Another boy, aged 17, travels 25 miles to his work and spends four hours in the transit. These hours, added to the working hours, leave very little time for meals at home, recreation or sleep. Similar instances for men could be given.

My general impression is that hours tend to be too long for the proper preservation of health and efficiency. Large number of boys are working a net average of 68¼ hours per week. Under certain conditions the effect upon their health is not so deleterious as in others, but, whatever the conditions, where more than one hour has to be spent in going to and from the factories, in my opinion, 68¼ hours are too many. Many of these boys are just over 14 years old, and they spend considerably more than two hours per day in travelling, thus having very little time for recreation or for rest. The natural bent of most of us is to revolt against a yoke of any kind in modern times. This is just what happens. The boys have found from experience that they cannot comfortably work over 60 hours per week, and as evidence of this—in one shop, where 600 boys worked, 500 of them on a Saturday afternoon did not return to work.

The same state of affairs, with a few exceptions, is found up and down the country. On the night shifts, boys do not tolerate well long hours, and in one factory a very large percentage of the boys complained of sleepiness and disinclination for work. It has to be borne in mind that the average age of the boys examined would certainly not exceed 15 years, and it makes one consider very seriously the future of the rising generation. One factory was chosen for the specific purpose of examining the differences that existed where night work was not done, and where a modern installation added to the comfort of the workers. At this particular factory 5 o'clock was the nominal knocking-off time; from 5 to 8 a small number of the workers, both adult and juvenile, worked overtime, but in the main most of the workers left the factory at 5 o'clock. Some of the boys work occasionally until 4 o'clock on Saturday afternoons, but most of them had Saturday afternoon and all Sunday free. They were a clean, well-dressed, well-nourished, intelligent lot of boys. The hours for all the boys examined would average about 62 per week. Their wages were low, but in spite of this fact they all managed before leaving home to have tea, bread and butter, and frequently an egg, though many of them had to leave at 5 a.m. to reach their work at 6 o'clock. To show the advantages of restricted hours and good factory conditions, these boys in their spare time indulged in boating, swimming, cricket, football and golf caddying and cycling. Anyone going round this particular factory would have been struck by their healthy and intelligent appearance. On the other hand, many of the boys I examined at other factories are showing definite signs of the wear and tear to which they are subjected. Pale, anæmic, dull and expressionless, their conditions would excite great commiseration. Conditions outside the factory contribute their share, and if this war is to continue for a long time and these boys remain subject to conditions such as described, the effect upon their general health will be difficult to remedy. Many of these boys, by reason of badly managed homes, are very indifferently fed, and I found in

the course of my inquiry, boys coming to work who arose at 4.45 in the morning to travel many miles in order to reach their work at 7 o'clock, and that without food. These conditions cannot possibly be allowed to exist, and call for the severest condemnation.

In another munition town, steelyard labourers were found working as much as 108 hours per week. The work was very heavy, but the saving clause was the fact that they were pursuing their occupations in the open air.

The conclusions I have arrived at are that where the work is heavy and the factory conditions are bad it is imperative that the hours of labour should be restricted for both men and boys. At the present time there is, or there may be, a shortage of labour, but in order to safeguard against a further shortage in the immediate future it will be wise to limit hours.

LOSS OF TIME THROUGH SICKNESS OR ACCIDENT.

14. Appended is a table (24) of the amount of time lost, as stated by the workers themselves, through non-preventable causes by the men and the boys. Among the 1,543 men the time lost during 12 months from all causes is 12,964 days, of which 20% was due to accidents and 80% to illness. The comparison of the various groups is interesting.

Of the men in health group A, 25% lost some time through sickness, the average days lost per man are four, and the average days lost by the men who lost any time are 16; for the B, C and D groups together the corresponding figures are 43%, 16 and 30. The accidents on the other hand are not more frequent among the less healthy, 7% of the A men being involved with an average loss of 26 days, and 4% of the others with an average of 24 days. It was shown above (para. 10) the proportion of physically unfit increased with the length of hours of work in the case of the post-war employees, and it should follow that the amount of time lost through sickness should also vary with the same factor. As far as the data are available for the necessary analysis, however, it does not appear that there is a direct relation between length of shift and lost time. The conditions grouped as "rheumatism" account for 38% of the time lost for sickness, and for 22% of the 950 men who lost any time, the figures for respiratory diseases, including "colds," being 25% and 42%. The remaining third of the time lost is distributed among a variety of afflictions of which digestive disturbances are the most frequent.

Among the boys, 53% of the lost time is due to illness, 47% to accidents. The less healthy boys (B, C and D groups) lost twice as much time as the healthy, 36% of the former losing some time against 19% of the latter, the average days lost per boy being five and two respectively. On the whole the boys lost through illness only about a third of the time lost by the men. The accidents are equally distributed among the health groups. Digestive and respiratory disturbances, with various infectious condition, account for about two-thirds of the total illness.

CONSIDERATIONS ARISING FROM VARIOUS FEATURES IN THE ENVIRONMENT.

15. *Wages.*—For the most part I found that wages were adequate to provide good food for the workers, and in this direction the general rise in wages has been beneficial. Many of the small boys dwelt on this subject at great length, informing me that since they had gone into the munition factories and taken home good wages they had been much better fed. In some cases, however, the wages earned were certainly not sufficient to furnish satisfactory home conditions for the workers and their families, and in others though high wages were earned, often by several members of the family, the overcrowding at home was considerable. It is hardly my province to discuss further this most controversial and complex question of wages, though in all its ramifications it has clear bearings of an indirect kind on the health of workers.

16. *Nutrition.*—Output in regard to quality, amount and speed is largely dependent upon the food of the workers. The conditions of factory work often make it impossible for the worker to have his principal meal at home, and frequently the facilities for obtaining refreshments in the neighbourhood are insufficient. Only four of the factories I visited had made this valuable addition to their establishment. All the arrangements at the first factory were perfect. The space allocated was ample for those employed, and a large number of the workers, both male and female, took their meals at the canteen, while others patronised the various refreshment rooms close to the works, or returned to their own homes. The kitchen equipment was model in every detail, and the cleanliness of the whole place was delightful. The service was most expeditious, 300 dinners being served in seven minutes. The method of keeping the meals hot was very good, a special dish cover having been devised by one of the employees and proving most efficient. Any food brought by the workers was heated or cooked free of cost, and boiling water was also supplied free. Trolleys containing food such as Bovril, soup, sandwiches, pork pies, mineral waters and coffee were taken round all the shops at 11 a.m., 4 p.m., and 3 a.m. The canteen was open for both day and night shifts. In the second works canteens were numerous, but could in no way compare with the above. The lighting and ventilation were not good, and on many occasions the temperature of the dining room was so high as to be oppressive. There was a great lack of tidiness, and the service was poor. In various areas of these very large works were numerous coffee stalls, managed by voluntary workers; and my experience was that the quality, cleanliness and general arrangements were much better than those at the canteens. At the third factory, a dining room is provided, but there is no provision for serving dinners; food brought in can be either warmed or cooked. Confectionery, chocolate, tea, coffee and boiling water are provided. In the fourth factory, the canteen arrangements were fairly good, about 50 men per day availing themselves of the advantages offered. The quality of the food was good, it was provided at first cost, and prepared under good conditions. A specimen meal included liver and bacon, peas, potatoes, and fried bread pudding for 7d. Tea, coffee, cocoa and other light refreshments are provided at very small cost. At one large steel works employing more than 10,000 men no canteen was then provided, though an attempt had been made to overcome this defect

by two coffee stalls, where light refreshments are on sale at stated hours of the day. In this factory there was, throughout the workshops, an excellent provision of warm cabinets, which were well maintained and whitewashed every fortnight. In another factory, in the same town, employing almost as many operatives, there was no provision of any kind.

Provision of forms with backs would add very materially to the comfort of the workers frequenting these canteens. I personally have not come across such provision anywhere.

As an example of the way the worker to-day lives, I may give here the results of my analysis for two groups of workers taken at random. Of 592 men, 14 of the men did not eat meat or fish per day at any meal, some because of their dislike for these articles of diet, the remainder because their wages and their responsibilities did not permit; 271 men consumed one meat or fish meal per day, 239 partook of two such meals, while 64 had three. Consuming four meat meals a day there were four men. Out of this number 151 went home to dinner at mid-day. Of 1,280 boys, 14 did not get meat or fish, partly because of bad domestic arrangements and partly because they disliked the diet; 312 of them have one meat or fish meal a day, 526 of them eat meat or fish twice daily, and 425 of them had three meat meals, whilst three of them enjoyed the luxury of four such meals. Out of this number only 136 go home to dinner at mid-day.

17. *Ventilation.*—Broadly speaking, the factories visited were well ventilated.. In some cases frequent complaints were made about draughts coming through the broken windows and partly open gateways. In the machine shop of one factory, though the rooms were very large, the air appeared to be stagnant and smelt stale, but this was due to the fact that the workmen would insist on keeping the windows closed. The assurances of those who appreciated a fresh atmosphere were to the effect that some arrangement was necessary whereby the workmen could not tamper with the method adopted. In the older portions of these rooms good ventilation was maintained by a system of fans, more especially in those shops where dust was prevalent. The exception to the general rule was found where steel was smelted in a practically closed-in shop. The atmosphere of this place was stifling, and in the summer time the temperature, when taken 6 feet above the level of the floor, was 136° Fahr. My experience of the machine shops visited is that some improvement which will not create draughts is necessary, for in all these shops the air is stagnant or appeared to me to be so. In every trade with exposure to heat the better the ventilation the greater is the comfort of the workers engaged upon the various processes.

18. *Lighting.*—Owing to air raids, the lighting of the factories at night has been somewhat interfered with, but speaking generally the arrangements are good. Whether by gas or electric light I found it adequate in every case. The placing or shading of lamps so that the light from them did not fall directly on the eyes of the operatives when engaged on his work was almost universal. These particulars were obtained by visiting various factories at different hours of the night shift. The natural lighting in almost every case would be good if the windows were cleaned regularly, but owing to the anti-air-raids darkening regulations the windows were not cleaned regularly, or if cleaned regularly the transmission of daylight is interfered with by blinds which have become dislodged or have got out of order and hang loosely about the windows. The advantage of whitewashing the walls and keeping the ceilings clean was shown by contrast with some of the workshops where these processes are sadly neglected.

19. *Washing Accommodation.*—Except in danger buildings and throughout Factory 2, washing accommodation is extremely defective. Even in those departments where factory legislation insists upon washing accommodation for workers handling lead and other similarly dangerous materials, the accommodation appeared to me not only insufficient but badly maintained. Complaints were made about the want of such facilities. In most of these factories where men are engaged in very dirty work, and even where basins with water laid on were installed, towels were not provided. Soft soap is given to the men engaged upon dirty, oily work, since it is difficult to clean thoroughly the hands without hot water and soap after being employed upon such work. The pleasure of changing into clean and dry clothing after a heavy day's work is considerable. Its influence would react upon the worker, who feels that he may go into crowded thoroughfares of large towns without being tabooed by a better-dressed and cleaner crowd. The argument may be advanced that the workers do not avail themselves of such opportunities as are provided. From personal experience I had the opportunity of appreciating the desire for washing by both men and boys. This occurred in a cartridge shop in Factory 1. The weather was warm, the work dirty, and whenever a boy or a man had the opportunity, he availed himself of the washing basin. From them I learned that they could have done with three times as much accommodation as was provided. No doubt in some cases prejudice to cleanliness might have to be overcome, but the result of my inquiries and observation has been that if the facilities were given, full use would be made of them. The boy workers are much keener about washing, and it is unfortunate that they should be brought up in industrial surroundings which prevent them from following up closely their present taste for cleanliness. The present day juvenile operative is not without his appreciation of regular cleanliness, but factory arrangements as I found them will assuredly create a condition of " laissez faire."

20. *Locker and Wardrobe Accommodation.*—Generally speaking, this is lacking; the workers arriving on wet days hang up their clothes in any corner which they can find, with the result that, on leaving, the apparel is almost as wet and sodden as on entry. The lack of drying rooms for such clothing is evident. In Factory 2 an excellent system of cloakrooms has been installed, and it was so arranged that steam could be passed through the hanging pipes to which the hooks had been fixed. In some branches of industry it is necessary for the workers, owing to exposure to excessive heat and the risk of their clothes catching fire, to saturate them with water. Large numbers of men, for example, in Factories 3, 5 and 6 are, for the most part, wearing clothes which are wet almost all day long. Some of them change their things before leaving, but others are forced, partly through lack of accommodation, and partly owing to custom, to go home as they are. In one factory some slight provision in the way of huts is made for these workers, but the clothes taken off at the end of the shift are in a damp and unwholesome condition on their arrival at work the following day. Apart from the pleasure of changing into dry clothing, the risks to health are considerable.

21. *Sanitary Accommodation.*—In almost all cases this was fairly good. In one or two instances, however, it was certainly insufficient and was not maintained as well as it should have been.

22. *Ambulance Arrangements.*—In Factories 1, 2 and 5 arrangements are made for dealing with accidents on the premises. The equipment at Factory 1 is excellent in every way, and it does not call for any description here.

In Factory 2 a large dispensary, contained in a private house adjacent to the works, is staffed by three trained nurses. The general arrangements are good. There is an ample supply of antiseptic dressings and a fair equipment of the necessary instruments with which to render first-class "First Aid." There is a trained nurse always on duty. In the event of any serious accident, the works doctor, who lives within easy distance, is summoned.

In Factory 5 the provision of surgery accommodation and ambulance room is good. There are two ambulance rooms in two distinct areas of the works, replete with all conveniences. Each contains two couches, a large number of splints, crutches, stretchers, &c., and each has its attendant in charge. The attendant has had a large amount of experience in these works for the past four years and is a certified ambulance man. Two medical men living within five minutes' journey are in touch by telephone with the works. At night-time, though no ambulance man is in attendance at the surgery, every workshop is fitted with a complete first aid installation, and from each works' office there is telephone communication to the central building, whereby if a serious accident happens necessitating medical attendance one of the two doctors above referred to can be summoned immediately.

In the remaining factories visited there was no adequate provision for dealing with even minor accidents. Some of the workers are ambulance men, but the condition of the equipment which I saw, where there was any, was disgraceful. It generally consisted of a bandage, a bit of lint or wool—usually very dirty—and some useless sticking plaster. The provision of proper material, carefully stored and easily reached, requires immediate attention.

23. *Welfare Work.*—In making these inspections I had ample opportunities of observing the working of the arrangements which have been made for "welfare supervision." The welfare worker should be in close touch with all matters affecting the welfare of the boys from a hygienic standpoint. In my opinion, too little attention has been paid to this aspect of the matter, and the first consideration should be the health of the operatives, male and female, adult and juvenile. Some elementary knowledge of hygiene should therefore be regarded as an indispensable qualification for a welfare worker.

24. *Housing conditions,* whilst not strictly a part of this inquiry, come within its scope because of their influence upon the work. There was considerable difficulty in obtaining clear evidence upon this point. Many of the workers are well housed, living in property which they have purchased, and taking a marked pride in its proper upkeep. Others, not so fortunate or not so provident, live under very bad conditions. In one town, for example, I saw three-roomed houses of the back-to-back type built round small courts, entered by narrow passages or by tunnels under houses facing the street, with rents from 3s. 9d. to 4s. 6d. per week. Large numbers of such houses are close to several of the works visited. It was found that many of the workers were living in one room only, but the variety of conditions under which they live is too great for brief description. Tables 25 and 26 summarise some interesting facts relating to sleeping accommodation.

TABLE 25.—An analysis of the home conditions of 392 adult males concerning sleeping accommodation.

Beds in room.	Number of persons, including workers, occupying each bedroom.					
	1	2	3	4	5	6
One	42 10·7 per cent.	252 64·3 per cent.	19 4·8 per cent.	1 ·32 per cent.	—	—
Two	—	12 3·1 per cent.	43 11·0 per cent.	11 2·8 per cent.	7 1·8 per cent.	1 ·3 per cent.
Three	—	—	—	—	—	1* ·3 per cent. (4 beds).

* This man earned £2 per week and had a large family.

TABLE 26.—An analysis of the home conditions of 188 boys concerning sleeping accommodation.

Beds in room.	Number of persons, including workers, occupying each bedroom.					
	1	2	3	4	5	6
One	29 15·4 per cent.	72 38·3 per cent.	17 9·0 per cent.	2 1·1 per cent.	—	—
Two	—	4 2·1 per cent.	27 14·4 per cent.	20 10·6 per cent.	12 6·4 per cent.	1* ·5 per cent.
Three	—	—	—	2 1·1 per cent.	2 1·1 per cent.	—

* This boy earned 14*s.* a week and three others were also working and earning money.

TABLE 27.—Showing the actual hours of sleep obtained.

——	Under 6 hours.	6 to 7 hours.	7 to 8 hours.	8 hours and more.
590 men	52 = 9 per cent.	173 = 29 per cent.	243 = 41 per cent.	122 = 21 per cent.
1,282 boys	1 = 0·1 per cent.	144 = 11 per cent.	495 = 39 per cent.	642 = 50 per cent.

TABLE 28—MEN.

Shifts.	When sleeping.	Number of workers. Sleeping. Under 5 hrs.	5 but under 6 hrs.	6 but under 7 hrs.	7 but under 8 hrs.	8 hrs. and over.	Total.	Hours of sleep. Rough total.	Average hours per person.
Day workers (not working on night shift).	Sleep obtained during night ...	3 2·0 per cent.	6 4·1 per cent.	36 24·3 per cent.	71 48·0 per cent.	32 21·6 per cent.	148	1,085	7·3
Day and night workers changing weekly.	Sleep obtained during :— Night...	10 4·1 per cent.	9 3·7 per cent.	59 24·2 per cent.	116 47·5 per cent.	50 20·5 per cent.	244	1,723	7·6
	Day ...	23 9·4 per cent.	30 12·3 per cent.	76 31·2 per cent	83 34·0 per cent.	32 13 1 per cent.	244	1,657	6·7

TABLE 29—BOYS.

Shifts.	When sleeping.	Number of workers. Sleeping. Under 5 hours.	5 but under 6.	6 but under 7.	7 but under 8.	8 and over.	Total.	Hours of sleep. Rough Total.	Average hours per person.
Day workers (not working on the night shift)	Sleep obtained during the night. ...	—	—	5 10·4 per cent,	22 45·8 per cent.	21 43·8 per cent.	48	376	7·8
Day and night workers changing weekly	Sleep obtained during :— Night ...	—	1 ·7 per cent.	22 15·7 per cent.	63 45·0 per cent.	54 38·67 per cent.	140	1,080	7·7
	Day ...	1 ·7 per cent.	2 1·4 per cent.	9 6·4 per cent.	40 28·6 per cent.	88 62·9per cent.	140	1,122	8

25. *Sleep.*—The necessity for a sufficient amount of sleep has been and is constantly referred to in questions concerning industry and overwork. Table 27 summarises the results of my inquiries in a long series of men and boys, and shows that on the whole the amount of sleep obtained is fairly adequate. In a second series (Tables 28 and 29) I have examined the relative times of sleep on day work and night work for 392 men and 188 boys. The boy workers were found generally to enjoy longer sleep when they slept during the day, one of the chief reasons being that the boy is not on tenter-hooks about being up in proper time for reaching his work. When sleeping during the day he generally remains in bed till the last moment, and then is " called " by his mother or some other occupant of the house, being allowed sufficient time to partake of a meal comfortably and get to his work. When sleeping during the night it is obvious that the risks of being late through not being called are very much greater.

Most of the men enjoy more sleep when it is obtained during the night. During the day many domestic duties prevent them from going to bed. When they are on the night shift, and even though they have the chance of remaining in bed, they frequently get up and have their meals at the usual meal-times, partly for the pleasure of being with their children and partly to save their wives trouble; in the case of single men, they may have to conform to the régime of the household in which they find themselves.

RECOMMENDATIONS.

26. The chief points which, in my opinion, require attention are:—

(*a*) Reduction of excessive hours, especially when bad transit makes a substantial addition to the effective working day, and in the case of boys.
(*b*) Provision and improvement of canteens.
(*c*) Provision of adequate washing accommodation in all works, with baths for workers in the hot and heavy trades.
(*d*) Improvement in first-aid equipment.
(*e*) Hygienic qualifications of welfare workers.

T. H. AGNEW.

APPENDIX.

1. Since completing the detailed inquiry which forms the basis of the foregoing report, I have visited four other districts in which steel manufacture is carried on, in order to compare the conditions of work and the health of the employees with those whom I had previously examined. A similar examination was conducted of about 700 workers, and the details, classified according to the plan previously used, gave results so similar to those already set out that further exposition is unnecessary. I think, therefore, that a satisfactory appreciation of the general health of the workpeople has been obtained.

2. In the first district nine works were visited, and a large number of men and boys examined. In all cases it was found that their general health was very good, and I found no evidence of undue fatigue. There were no complaints of sleepiness, restlessness, swelling feet or muscular pains: respiratory, circulatory and digestive disturbances were practically absent. In fact, all the men and boys reported that they felt very well. The teeth, however, were bad, and the general state of the mouth showed great lack of regular attention.

I am of opinion that this satisfactory state of affairs is due to the superiority of the conditions under which work is carried on, and I attach chief importance to the general prevalence of eight-hour shifts. The eight-hour day was introduced into this district about 16 years since, and has now been adopted in almost all the steel works; the opinion of the men on the question of hours is very definite, and they would under no circumstances return to 12-hour shifts. Apart from the question of hours, the environment is in general of a superior kind; the workshops are well placed in open areas, very well arranged, the ventilation free, and the whole clean and orderly. Wages are good and food is excellent.

In some respects, however, there is great need of reform. The appalling condition of the sanitary accommodation calls for immediate action. In some cases the provision is insufficient, and almost everywhere the condition of such conveniences as are provided is so revolting that it is impossible to describe. They are also commonly situated in almost inaccessible places, the approach to which is particularly dangerous at night. The provision of ambulances, first-aid outfits and surgery appliances is exceedingly scanty. There is no washing accommodation. Canteens are not provided, and appear to be unnecessary, as nearly all the men live close to the works.

3. In a second neighbouring district I visited five large works. The general conditions are much the same as in the first district, except that a 12-hour day is general. The boys and men generally were in good health, though their physique compared unfavourably with that of the employees in the first district. The sanitary accommodation was again very bad, and there were no arrangements for washing. The ambulance arrangements require much improvement.

4. In a third district in which I investigated six steel and iron works during November and December, the conditions varied a good deal from place to place. The work is mostly arranged in 12-hour shifts, the shops are large and well ventilated, and transit is good. There are some first-rate ambulance arrangements, but on the whole this wants much more attention; canteens are infrequent and washing accommodation absent, the standard of personal cleanliness among the workers being a low one. With rare exceptions, the sanitary accommodation is revolting, and urgently requires reform. Wages are good and the standard of living high. Public drunkenness was much in excess of anything I have seen elsewhere; and of 165 workers who were examined in detail only 54 per cent. reached the A standard; there were no clear signs of fatigue from overwork.

5. In a fourth district, an armament centre, I visited three large works engaged in steel manufacture and the rolling of boiler plates. The work was both very heavy and heavy, the exposure to high and varying temperatures was considerable, and at this particular season of the year the variations of heat and cold were extreme. The period of employment before breakfast was longer than in the works visited previously, the breakfast hour commencing at 9 a.m., after three hours' work. At two of the works under consideration the employees go home to every meal, but at the third only those living close to the factory avail themselves of this opportunity. The average length of shift is 12 hours for the tonnage men. The shifts change over weekly, and usually at Sunday midnight.

The shops were remarkably free from dust or fumes, and the ventilation, lighting and general cleanliness were good. In the rolling mills noise was considerable, and frequently it was difficult to hear a " shouting " voice.

The sanitary accommodation was, at one works, very good, and conveniently situated, having been reconstructed during the past two or three years; it was kept in a clean and orderly condition, a special man being detailed for this duty. At a second factory the accommodation was scanty, inconveniently situated, dark, and was not kept in a clean and orderly condition. At the third the structural arrangements were falling to pieces and the interiors were filthy and revolting, but I was informed that, at last, the directors have had plans prepared in view of a complete reconstruction.

Washing accommodation was not provided in any of the works. Cloak-room accommodation in the form of cabins or of shelters was good in all the smelting departments, but I did not see similar provision in the rolling mills.

In two of the works the workers gave the impression of living well, and this was confirmed by their own statements on the subject. At one factory particularly the men were a fine set, many of whom were total abstainers, whilst the remainder were, without doubt, very temperate. In the third works the standard of health was not good; the prevalence of alcoholic habits has an influence not only upon the appetites of the men, but also upon the character of the food. From this factory very few men go home to breakfast or dinner, which latter meal usually consists of merely a sandwich and a cup of tea or other " refreshment," but it was reported that a full meal was partaken of when home was reached in the evening. At this works there are cabins—clean, well-lit, and containing a stove, where workers can make tea or coffee and eat their meals. Canteens where hot meals are provided have not been established at any of these factories.

The " first-aid " arrangements were everywhere poor, although in all three works excellent ambulance rooms were provided; but they were poorly stocked with dressings, and such as were inspected were untidily kept and soiled. The rooms for this purpose were well arranged, centrally situated, and well provided with the necessary tables, couches, stretchers and basins, but they gave me the impression of being sadly neglected. In one works the ambulance room was rarely used, and the dressings were done in a " store," where the lotion bottles were kept close to a sink full of tea leaves and dirty crockery.

The general health of the workers was good, particularly in shops fitted with modern plant. There were no evidences of undue fatigue, and respiratory and digestive troubles were not prevalent. The chief causes of complaint arose from conditions commonly classified as " rheumatic," which claimed a large percentage of those examined.

INQUIRY INTO THE HEALTH OF WOMEN ENGAGED IN MUNITION FACTORIES.

CONTENTS.

THE NATURE OF THE INQUIRY.

1. In accordance with the instructions of the Health of Munition Workers Committee, an inquiry was conducted by ourselves and other selected women medical officers* and women inspectors,† whose services were lent for the purpose, into conditions affecting the health of women workers in certain munition factories. The inquiry took place between December, 1915, and July, 1916, and included a survey of factory environment, hours of work, transit, domestic circumstances, &c, together with the effect on the health of the workers as revealed by a medical examination. The medical inspection was necessarily brief and usually occupied 10 to 15 minutes. Generally speaking, the doctors' inquiry was held in a surgery or rest room, but on some occasions less suitable premises had to be used in order that the medical examination might take place near the factory shops to avoid delay and consequent interference with output. In a few instances the noise of machinery or the absence of sufficient privacy prevented a thorough examination of the chest, but it was at least possible to ascertain whether the women were suffering from symptoms indicative of slight or marked fatigue as the result of their factory work.

SELECTION OF WORKERS.

2. Groups of workers were chosen to include representatives of the various processes carried on in the factories. An attempt was made to select those who had been in employment for at least three months, and to avoid unfairness workers were chosen at random, *e.g.*, every third or fourth girl at a bench. The total number of women workers examined was **1,326.** The examination was confidential and entirely voluntary as far as the workers were concerned. In practically all cases they showed every willingness to answer questions and to submit to the medical examination.

---

* The medical officers who took part in one or more inquiries were Dr. Ada Whitlock (Home Office), Dr. Beatrice Webb, Dr. Ethel M. Stacy, Dr. L. M. Chesney, Dr. Mabel Campbell, and Dr. Ethel Williams.

† The women inspectors who assisted in one or more inquiries were Miss Hilda Martindale, Miss H. C. Escreet and Miss Irene Whitworth (Home Office), Miss E. M. Gardner and Miss E. G. Woodgate (National Health Insurance), and Miss E. G. Colles (Board of Education).

NUMBER OF FACTORIES VISITED.

3. Reports were received of visits to 11 factories in England and Scotland, which were selected with a view to obtaining a general survey of typical conditions. In every case the management of the firm were most courteous and did all in their power to facilitate the investigation.

Factory No. 1	...	...	105	workers examined.
,, ,, 2	...	...	82	,, ,,
,, ,, 3	...	...	149	,, ,,
,, ,, 4	...	...	210	,, ,,
,, ,, 5	...	...	130	,, ,,
,, ,, 6	...	...	70	,, ,,
,, ,, 7	...	...	100	,, ,,
,, ,, 8	...	...	170	,, ,,
,, ,, 9	...	...	156	,, ,,
,, ,, 10	...	...	40	,, ,,
,, ,, 11	...	...	114	,, ,,
	Total	...	1,326	

GENERAL CONDITIONS OF EMPLOYMENT.

4. The types of work in which the women were engaged included the manufacture of shells, bullets, cartridges and fuzes, and covered a wide range of processes, including employment in danger buildings. No workers in T.N.T., &c., were examined. Much of the labour was unskilled or semi-skilled, so that workers were not infrequently changed from one operation to another with little difference to output. The following extract from one of the reports indicates the type of work carried out:—

> " *Feeding of automatic machines.*—If 100% be taken as the maximum which can be obtained from any machine, it is obvious that this can only be done under ideal conditions. These conditions are never present even in a highly organised concern; the material, the machine and the minder vary in changing proportions. It is customary to allow a percentage for the machine, for time spent in setting and grinding tools, &c. A further percentage must be allowed for the degree of skill of the worker, and thus, with a reasonably steady flow of material, some idea of the result to be obtained can be aimed at. In fixing these percentages account must be taken of the human factors in machine manipulation, the tool setter and the minder.
>
> " The tool setter's art consists in making the machine run smoothly; if it is necessary for tools to be removed for grinding, he must remove and replace them as expeditiously as possible. It is obvious that the percentage to be allowed will depend to a great extent on the skill of the tool setter. In the factory under consideration the machines are untried, the trained men are limited, and each has a gang of learners under him.
>
> " Very little skill is required from the machine minder, and in this factory almost all are being taught the work from the beginning. In order to attain anything like proficiency, dexterity is necessary, and experience tells. It was stated on all sides that it is difficult to lay down any hard and fast rule; one individual may pick up the work at once and ' earn her money ' the first day, while another may take longer and never attain any great speed. The human element enters even into the feeding of nickel ' cups ' into the revolving disc of a machine which is to ' draw them through ' to a stage nearer their finish as ' envelopes '; it is possible to miss holes as the disc revolves, through tiredness or inattention. It is even possible to introduce variableness into the tending of a metal slide full of cartridge cases which descend into a ' tapering ' machine; the slide must be kept full, the cases must be fed in with their heads in the same way, they must lie evenly side by side in the slide, or the very delicately constituted machines which deal with them will be thrown out of gear and require the spending of much skilled time and attention before again being able to work.
>
> " Lathe work requires slightly more concentration than the automatic machines, and is, in the workers' language, slightly more ' tedious.'
>
> " Power and hand-press work require considerable concentration, as the nervous strain is not slight. Risk of accident is always present, and experience is necessary in order to overcome the timidity attendant on this. Though the risk is greater on a power press, the worker's variability is equally great, if not greater, on a hand press, where muscular action enters into account as well as mental strain.
>
> " *Examining.*—Examining is said to be the most ' tedious ' of the operations; it is the one which requires most thought as well as close attention. The examiner's work lies in the application of her own intelligence to the object in hand. She has no artificial aid of gauge, machine or scales to help her. She must think, however slowly she does it, and her experience will tell, not so much in the direction of manual dexterity, though this is of great assistance, as of quickened intelligence.
>
> " *Light bench work, some involving contact with lead, some not.*—This work requires no skill at all : it merely consists in dropping lead pellets into nickel ' envelopes,' as the outer shell of the bullet is called.
>
> " Bullet weighing and case and bullet gauging can also be performed without experience and to some extent mechanically, though here, as in the above and other operations, experience tells. The worker is only concerned to watch the scales or the gauge and keep them in use, and her variability depends on how constantly she does it."

HOURS OF WORK.

5. The long hours of work were frequently complained of by the workers, and in some cases the hours worked were undoubtedly excessive as, for example, in *Factory No.* 4 where women were employed 77 hours weekly, and 15·5% of the workers showed evidence of marked fatigue. At

Factory No. 8 the hours were also long in most departments. The following table shows the hours worked in a large shop in this factory:—

Shifts.	Meal hours.	Longest spell without break.	Hours worked per week (excluding meals).
Day Shift.			
Sunday–Friday, 7–7	*[8.30–8.45] 12–1 4–4.30	3¼ hours	68½
Saturday, 7-1	8.30–9	4 hours	
Night Shift.			
Sunday–Friday, 7–7	10–11 2–2.30	3 hours	63
Saturday, nil.	*[5–5.15]		
(Shifts changed weekly.)			

The report states:—" The workers did not, as a rule, object to night work, but there is a strong feeling amongst them, which is practically unanimous, that the hours should be shortened. They have made up their minds that work should stop not later than 6 o'clock, and that they should have one day off in the week—Saturday being the day usually suggested. The chief argument brought forward in favour of this alteration is that from 6 to 7 p.m. very little work is done. Most workers have ' earned their bonus ' by that time and they will not start on a fresh lot of work. They sometimes ' help along the lines,' *i.e.*, help any workers who have not earned their bonus, or they spin out the cleaning of their machines which could be done in a very few minutes, or they ' stand and rest at their machines,' not being allowed sit down. The reason generally given is that they are ' properly tired out ' by 6 o'clock, and ' would not be fit for work next day if they did more than that.' "

At *Factory No.* 3 the following hours were worked:—

Hours worked.	Meal hours.	Longest spell without meals.	Hours worked per week.
Scheme A.			
Day— Sunday, 8.30–5	Sunday, 12.30–1.30	4 hours	67
Monday–Friday, 6–5.30 ...	Monday–Saturday, 8.15–8.45		
Saturday, 6–5	12.30–1.30		
Night—Sunday, 5.45–5.45	Sunday–Friday, 9.30–10.30 ...	4¼ hours	63
Monday–Friday, 5.45–5.45	2.45–3.15 ...		
Saturday, nil.			
Scheme B.			
Day— Sunday, 8.30–5	Sunday, 11.30–12.30	4½ hours	69
Monday–Friday, 7–7	Monday-Friday, 11.30–12.30...		
	4.30–5 ...		
Saturday, 7–5	Saturday, 11.30–12.30 ...		
Night—Sunday, 7–7	Sunday–Friday, 10.30–11.30...	4 hours	63
Monday–Friday, 7–7	3.30–4.0 ...		
Saturday, nil.			

Here " several workers stated that they found the hours very long and that the night work was more tiring than day work, but few strong representations were made on these points, and often the contrary was stated. On the other hand there was strong and wide-spread feeling against Sunday work, both day and night, more especially Sunday night. In spite of the extra shilling given for Sunday work a strong desire to have this day free was expressed by a considerable number of workers." Indeed, Sunday work was generally found to be unpopular.

At *Factory No.* 1 it was found that output was greater when 8-hour shifts were worked. At this factory the periods of unbroken work were sometimes as long as five hours; in these cases owing to difficulty in transit workers were sometimes six or seven hours without food, and stated that " on reaching home they were too tired to eat." This arrangement was particularly unsatisfactory in view of the number of young workers under 18 who were employed.

*" Unofficial " meal-times. The workers do not leave their machines.

LOST TIME.

6. Inquiries were made of the workers as to lost time, and their reasons for remaining away from work. It was not easy to obtain reliable data. At *Factory No.* 8 " no records of lost time have been obtained from the firm in respect of the workers interviewed, but from their statements it appears that this must have been considerable. There are a few very regular workers who take a pride in not losing time, and there are others who ' can't afford to stay away '; but there are many who have been away a good deal on account of illness, and who, apart from actual illness, take a day or a night off for a rest when they are feeling tired or run down. Some make a practice of taking a day off once a week or once a fortnight, and maintain they work better in consequence." In regard to *Factory No.* 3 it was stated that " with few exceptions the amount of time lost through illness or other reasons is remarkably little considering the long hours worked and the long period for which they have been worked. There are about a dozen cases of illness lasting three weeks and upwards, but apart from these, periods of absence were short and few according to the workers' statements. An odd day or a ' breakfast time ' was taken occasionally when the worker was feeling ' tired-out.' Records of time lost during the last four months by 74 of the workers interviewed have been supplied by the firm, giving the total number of whole days lost as 121 (*i.e.*, 1·6 per worker), and the number of ' quarters ' lost as 60 (*i.e.*, 0·8 per worker)." On the whole, the timekeeping was good, and the women only absented themselves on reasonable grounds.

POSTURE.

7. At certain factories an unnecessary amount of standing seemed to be enforced. In some cases this was due to insufficient seats, but in many cases it was stated that foremen did not allow girls to sit even while their machines were being repaired. At *Factory No.* 2 " girls in one hut who work standing and have considerable intervals when they are kept waiting for work, complained that they had no seats which they could use during the intervals."

At *Factory No.* 1, " in the head-turning department where the work is heavy, the workers complained of the refusal of the foreman to have them supplied with stools. They all stated that they could work better sitting than standing, and many complained of faintness and exhaustion caused by the continuous standing. In consequence of their protests eight stools had been provided to be shared among 14 people, but no more could be obtained. Before we left the factory the foreman undertook that each of these workers should be supplied with a stool as quickly as possible."

At *Factory No.* 8, " many complaints were received that workers who usually stand at their work were not allowed to sit down at all during working hours—even when their machines were being repaired or they were kept waiting for work. Apparently the foremen are afraid that if they sit down at all they will be reluctant to get up and start work again when the machine is repaired." At another factory " complaints were made by some of the workers in the head-turning department that they had no stools, and were never allowed to sit down even when waiting for work or for repairs to their machines. As each worker is in charge of two machines, they state that they must stand while actually working, but would be glad of the opportunity of sitting down in the intervals of waiting for work, &c. In the heading department and the hand cut-off department (cases), workers expressed a wish for stools, and said that their work could be done equally well sitting or standing In the finish press (bullet) department and the final view (case) department, complaints were made that the number of stools provided was insufficient, and that some workers had to stand in consequence."

At one factory general muscular pains were found to occur in 26% of the workers examined, and a number of the elderly women complained of the fatigue of standing all day; at a re-examination of these workers six months later seats had been provided and complaints of fatigue and backache, &c., had markedly diminished.

NUTRITION.

8. A satisfactory standard of nutrition is of the highest importance in maintaining a proper level of physical efficiency. This is dependent indirectly on many factors, such as domestic conditions, fresh air and exercise, wages, convenience of transit, &c., but the most urgent requirement is the provision of proper meals at suitable hours. The association between a satisfactory diet and good physical health was usually clearly observed. For example, at *Factory No.* 11 it was noted that the women who as a whole were exceptionally robust ate particularly solid and suitable meals; in addition they worked under good hygienic conditions, and for the most part lived near their work, factors which contributed to an excellent standard of general health. At *Factory No.* 9 the meals were also adequate and substantial in the great majority of cases, a typical dietary being as follows:—

On rising	...	Tea, toast or biscuit.
9 a.m.	...	Porridge; ham and egg; toast or bread; tea.
11 a.m.	...	Fruit.
1 p.m.	...	Soup; meat and potatoes; sometimes pudding; tea.
3.45 p.m.	...	Fruit or cake.
6 or 7 p.m.	...	Plain tea, sometimes fish or egg.

In contrast to these examples, in the case of *Factories* 1 *and* 2 there were difficulties of transit, the factory environment was not always convenient, and unduly long intervals often elapsed without food; neither factory had a welfare supervisor. The proportion of workers showing marked fatigue was high. The report on one of these factories runs:—

" The arrangements for meals at the factory appear to be far from satisfactory. A dining room is provided with pipes for heating up food previously cooked, but with no other cooking facilities and practically no attendance. The girls describe the room as dark and cheerless, and many prefer to eat their meals in the work room or cloak room. The arrangements for night workers are particularly bad. Hot water is obtainable for making tea, but nothing can be warmed up at all, and the workers unanimously expressed the opinion that their work and health would benefit if they could have something hot in the 2 to 2.30 a.m. interval when they are feeling cold and tired." In another case " for seven shops employing nearly 3,500 women by day and 2,590 by night there are two canteens run by caterers with accommodation for 750 at one and 300 at the other. In addition, a third canteen is shortly to be opened which will provide for another 500; *i.e.*, there will be canteen accommodation for 1,550. As all the workers have their chief meals simultaneously and as night shifts are continuous this is quite inadequate. Moreover, the second canteen is hardly patronised at all; the reason given for this is that the workers do not like it—it is too far to come to during the night in the dark. The girls from shop A have to come out from an exit some distance down the road. The firm have one mess room for the use of girls in shop B; here the food is well cooked and the workers much appreciate it; there is room for all employed by day or night. There are facilities for warming brought food in shops A and C." In this case also the amount of fatigue observed was considerable.

In *Factory No.* 3, the workers were in good health as a rule, while " the canteen arrangements appear to be fairly good and to be appreciated by the workers. The food provided is of good quality and variety and is sold at a moderate price. Soup can be had for 1d., meat and vegetables for 4d., and other dishes at corresponding prices. Many workers bring their own food to be cooked or warmed up. The workers appear on the whole to be well fed. Most of them before starting in the morning have a cup of tea, with nothing or very little to eat, and have their main breakfast at the factory."

9. Speaking generally, it was satisfactory to note that the workers realised their need for nourishing and substantial food, and were in fact eating much better meals than many of them were accustomed to before the war. This had certainly had considerable influence in enabling them to stand the strain of long hours, &c., as well as they have done.

TRANSIT.

10. The arrangements for transit showed much variation. In cases where the workers lived near the factories, *e.g.*, Factories Nos. 9, 10 and 11, they were not only spared the fatigue entailed by a journey in a crowded train or tram before and after work, but they were able to take many meals at home and had increased time for exercise and recreation; this certainly had a distinct effect for good on their health. In other cases the difficulties of transit were acute, as is instanced by the following examples:—" The length of time spent in travelling is a noticeable feature in connection with this factory. This is partly due to the fact that a number of workers come in daily from outlying districts, but it is also largely attributable to the exceedingly bad car service, about which there was universal complaint. In the morning workers often have to allow twice the time that would ordinarily be taken to travel the distance to the factory, and even then they are frequently late. It is said to be not uncommon to wait 20 or 30 minutes before being able to get on a car, and then a worker considers herself lucky if she finds standing room." (*Factory No.* 9.)

In another case the medical officer remarked:—" It is noteworthy that a comparatively large number of workers live at some distance from their work—in 57 cases out of 149 the journey occupied at least 30 minutes each way. Frequently car journeys took 45 minutes, and many complained that cars were both late and crowded. The fatigue of standing in a crowded car after a struggle to gain admission adds considerably to the severity of the day's work, and many of these girls complained of muscular pains in the feet or back. Expense of transit sometimes proved a difficulty—one or two workers walked to save fares, including a widow aged 53 years, whose journey took one hour each way." (*Factory No.* 3.)

At another factory " many workers stated that the trams were irregular and crowded, and that they often had to wait a considerable time—sometimes half an hour or more—*in* consequence. There were many complaints also as to the overcrowding on the brakes provided by the firm to convey workers to and from the tram terminus (25-30 minutes' walk from the factory), many saying that they preferred walking to joining in the struggle for a seat." (*Factory No.* 1.)

PERSONAL HYGIENE.

11. At most of the factories the facilities for washing were unduly limited, cloak-room accommodation was scanty, and sanitary conveniences were not always adequate in number. The absence of reasonably good arrangements for cleanliness, &c., cannot fail to exercise some detrimental effect on the health.

The report on *Factory No.* 2, for example, states " the washing accommodation is worse than the sanitary accommodation. There are only three basins with cold water (no soap or towels) for the whole of the fuse department—300 women and girls, of whom only about 18 actually handle mercury, but all get dirty, and want provision made for washing. The girls who lacquer complain most bitterly. In the ' A ' Department 52 women handle cordite and gunpowder, but there are no washing facilities. The 66 girls in the emergency shop are equally strong in their statements that they need washing accommodation, but have none."

Another report states:—" The washing conveniences, which seemed hardly sufficient, comprised basins with cold water laid on. Very few towels were provided, and the workers purchased their own soap."

Again:—" In the bullet department there are only nine basins with cold water and nail brushes provided for 130 girls, 30 of whom handle lead. Soap can nominally be obtained from the forewoman, and towels, conspicuous by their absence, are supposed to be provided bi-weekly to each of two sets of basins. Complaints are made by foremen that towels, &c., are stolen and the workers complain of lack of accommodation. Very little washing is done, I think, although the girls' hands get black." In another case " washing facilities are quite inadequate, workers in some departments being unable to wash their hands at all before meals, though at most processes they become very dirty. Many state that they clean their hands with oil, though they are not supposed to use oil for this purpose; others wash their hands in the water running from their machines. Even those who handle lead do not always wash their hands before meals; these latter state that five minutes is allowed for washing, and that hot water is provided but no soap or towels."

Washing facilities in the factories have, no doubt, been improved since the reports were made. Another difficulty experienced by the workers is in obtaining hot baths. Many use the public baths, but these are not always convenient, and may be crowded.

MEDICAL INQUIRY.

12. As the result of the medical examination, the workers have been classified in three groups:—

A. denotes apparent good health.
B. denotes those showing signs of fatigue or ill-health.
C. denotes those showing marked fatigue or ill-health.

The results were as follows:—

England.	Number of workers examined.	A (healthy).		B (slight fatigue).		C (marked fatigue).	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Factory No. 1 ...	105	62	59·0	31	30·0	12	11·0
„ 2 ...	82	50	61·0	22	26·8	10	12·2
„ 3 ...	149	98	65·8	44	29·5	7	4·7
„ 4 ...	210	129	61·4	69	32·9	12	5·7
„ 5 ...	130	65	50·0	50	38·5	15	11·5
„ 6 ...	70	37	52·9	25	35·7	8	11·4
„ 7 ...	100	38	38·0	49	49·0	13	13·0
„ 8 ...	170	68	40·0	82	48·2	20	11·8
„ 9 ...	156	107	68·6	40	25·6	9	5·8
„ 10 ...	40	26	65·0	11	27·5	3	7·5
„ 11 ...	114	83	72·8	28	24·6	3	2·6
Total ...	1,326	763	57·5	451	34·0	112	8·5

AILMENTS.

13. As the medical examination was conducted by several medical officers, allowance must be made for the personal factor in considering their findings. A table* is attached giving percentages of the most common defects found at each factory. The ailments most frequently observed included indigestion, constipation, headache, anæmia and muscular pains. These are all frequently met with among women workers, and cannot be attributed specially to munition work. The great difficulty in estimating their precise importance was the lack of any control investigation or data. In some cases the ailment had undoubtedly been caused or accentuated by the conditions of factory work; in other cases it had existed before beginning munition work; in others, again, the workers expressed themselves in better health than formerly.

Indigestion in many forms was noted, but occurred less frequently than had been anticipated. Pain after food was fairly common, but was often explained by an unsuitable choice of food, particularly on the night shift. The amount of tea consumed is large, but the tea seemed practically always to be freshly made, and was drunk at once, so that ill-effects were probably not produced as a rule.

Constipation was more marked than appears from the table.* Most workers seemed to take aperients fairly regularly, and in consequence of this habit may often have reported themselves as not constipated. In one factory the practice of taking aperients was most noticeable; nearly all the workers, and especially the younger ones, took salts, usually with their morning tea, two or three times a week, before beginning work. Lack of appetite was most frequent on the night shift, a considerable number stating that they could not eat substantial meals in the night. Many had no desire for a proper breakfast. The teeth were often carious and septic, but no constant association between indigestion and defective teeth was observed.

Headache was often an accompaniment of anæmia or constipation, and in other cases was doubtless due to eye strain. In two cases where a second medical examination was conducted six months after the previous one it was found that 10%-15% of the workers had obtained dental treatment in accordance with medical advice and the amount of headache was appreciably lessened.

* *See* pages 120 and 121.

Anæmia was particularly common where arrangements for meals were not satisfactory and difficulties of transit existed. It was usually relatively slight in degree, and no case of really severe chlorosis was discovered. Some workers were classed as " C " in whom anæmia accompanied by a marked hæmic murmur was noted.

Muscular pains, foot-ache, &c., often due to prolonged standing, were common, especially in the case of workers who had not become accustomed to the work or had not a good enough general physique to withstand the fatigue. Few cases of marked flat-foot were noted, and the foot-ache usually disappeared to a great extent, though the feet and ankles of girls obliged to stand during the whole shift were apt to become swollen towards the end of the day or on the night shift.

A small amount of *organic disease* was detected, usually either early phthisis or heart disease. A few of these women were obviously unfit to continue their work in the existing conditions, but others, especially the heart cases, had not apparently suffered in health.

Disorders of menstruation occurred in a certain proportion of workers, and in some cases these had increased with factory life, usually either in young workers unaccustomed to standing or in older women with climacteric symptoms. Here, again, the effect of the conditions of employment was less marked than had been anticipated. The provision of a rest room, conveniently situated, and in charge of women attendants or a nurse, is most desirable. At one factory the girls did not care to avail themselves of the ambulance room, as it was in charge of a male attendant and was also visited by men workers for the treatment of minor injuries.

SPECIAL POINTS OF INTEREST.

14. Some special points of interest which emerged from the findings at certain factories are worth recording:—

(*a*) Effect of factory life on married women.
(*b*) Length of service in relation to strain.
(*c*) Relation of age of workers to fatigue shown.
(*d*) Eye-strain in relation to factory employment.

(*a*) *Effect of factory life on married women* was observed in two medical examinations carried out at Factory No. 4 within six months of each other. In the first case 210 workers were examined, and in the second 116 of the same women were seen again.

The married women re-examined at the factory included 31% who mentioned difficulties in home conditions or suffered from the strain of night work, as they often obtained too little sleep during the day. Chronic rheumatism occurred in 12%. Ten women had remained quite healthy; these included young women either without children or who undertook no household duties, and a proportion of elderly women of over 40 years of age, of the charwoman type, who were especially strong and wiry. Several mentioned the improvement which had resulted from their being given work at which they could sit instead of having to stand; and some had ceased night work.

Married women interviewed in their homes had left the factory for reasons of health in 26%, or on account of low wages and long hours in a similar proportion (26%). Some had secured work in other factories in the district where no Sunday labour was required. An additional 15% had left on account of pregnancy, and 15% had ceased going out to work either for health reasons or for home affairs. One case could not be traced, and one worker had left on account of chronic rheumatism.

The numbers under consideration are too small to afford definite conclusions, but in reviewing these cases the general impression was obtained that the long shifts and night work, in addition to home duties and worries (often associated with insufficient sleep), formed too heavy a burden for the average married woman.

(*b*) *Length of service in relation to strain.*—Factory No. 3; 134 workers reviewed.

	3–6 months.	6–9 months.	9–12 months.	12 months and over
Number of workers considered (total 134) ...	15	43	37	39
	Per cent.	Per cent.	Per cent.	Per cent.
Percentage of healthy workers	33	9	19	38
Digestive disturbances	33	29	28	20
Headache	20	42	49	28
Faintness	7	29	32	13
Anæmia	27	16	24	33
Muscular pains...	27	9	19	21
Sleeplessness	13	9	19	20

Muscular pains occurred in 26·6% of workers between three-six months, and were at first probably largely due to general bodily fatigue, unfamiliarity with machinery, &c. They appeared to pass off as the girls became accustomed to the work, and from six to nine months were present in only 9%. The condition continued throughout factory life in an increasing degree, and was found among 20·5% of workers who had been more than one year in the factory. In such cases it seems due to fatigue resulting from the nature of the work, possibly accentuated by difficulties of transit or general causes.

Headache and faintness were slight in the first few months of work, but steadily increased between six and nine months, and nine and twelve months, when the maximum was reached, the figures being 48·9% headache and 32·4% faintness. From this point came a decline, and the figures over twelve months' work strongest workers, and it is worthy of note that 38·4% of workers over one year's standing were found to be free from any physical defects.

Anæmia was fairly marked between three and six months, possibly owing to new conditions of life. The healthiest period seemed to be from six to nine months, when the percentage was 16, but the figures steadily rose as factory life continued, reaching 33% in workers of twelve months and upwards.

Sleeplessness was most marked between nine and twelve months, especially in those on night duty. After this the habit of sleep was again established except in the case of a few elderly workers of many years' standing, where possibly factory work was not the main cause of the condition.

The numbers are too small to form anything but a rough guide, but tend to show that for the first six months of factory life the work is usually fairly well borne and the effects of night duty show little ill-result. In the six-twelve months' interval the strain begins to produce effects on the weaker members of the factory, and an increased amount of headache, dizziness and sleeplessness is experienced, especially on night work. The data concern, of course, only those found at work, and are no criterion of what effect may be produced upon those—and their number is not inconsiderable—who for various reasons give up industrial employment after a short trial.

(*c*) *Relation of age of workers to fatigue shown.*—Examination of 210 women and girls at Factory No. 4. It should be noted that the hours of work at this factory were then exceptionally long.*

A table follows showing the relation of the age of the workers to the amount of fatigue experienced. It will be seen that 44% of the workers aged 14 were suffering from slight or marked fatigue when medically examined, although the majority had been employed under four months and some of them for a much shorter period. Among the workers aged 16 to 20 about 55% found the long hours tiring. The heaviest proportion of those suffering marked fatigue occurred in the age group 30 to 40, but here it should be remembered that these numbers include a proportion of married women in whose case conditions of home work aggravated the strain of factory life.

A decline in signs of fatigue is noticed in the age group 40 and upwards, among whom were several elderly women of a wiry type.

Age.	Number of workers examined.	Fatigue.		
		No obvious signs.	Slight.	Marked.
		Per cent.	Per cent.	Per cent.
14	25	56	28	16
15	15	73	20	7
16–20...	65	45	43	12
20–30...	63	49	40	11
30–40...	30	40	30	30
40 and over	12	58	25	16
Total	210			

A second medical inspection of 116 of these workers six months later revealed that on the whole the young workers (aged 14 or 15) showed improvement in health since the previous examination. Of 39 girls, 20 were quite healthy, 7 showed slight signs of fatigue, and 12 were no longer at the factory. Those who had left had usually been removed by their parents on account of long hours or dislike of night work. The ventilation of the main shop had been improved and defects due to faulty temperature were no longer marked; on the other hand the July inquiry showed a rise of 10% in the number of cases suffering from marked fatigue (possibly in part due to unsuitable arrangements for feeding).

(*d*) *Eye strain in relation to factory employment.*—This point was considered during the examination of 156 workers in Factory No. 9. In contrasting the eye conditions found in different shops in this factory it will be seen that most defects occurred in the fuse department where fine processes were in operation involving close attention and considerable likelihood of eye strain. In the work of machining shells only 18·7% of eye defects were noted, but in the fuse department the proportion of eye defects reached 64%.

* The report states :—" Young persons of 14-18 years have been employed the 77 hours a week continuously, *i.e.*, Monday-Friday, 7 a.m.-9 p.m.; Saturdays, 7 a.m.-5 p.m.; and Sunday, 9 a.m.-4 p.m. Meal times amounting to 1¾ hours were required by the Order, but only 1½ has been given in many departments, one break being omitted and a continuous spell of seven hours being worked."

The following table gives the results of inquiry as revealed by the workers' statements or by the more obvious signs of eye strain:—

——	Machining shells.	Inspecting shells and fuzes.	Fuze department.	Total.
Number of workers examined	32	23	101	156
Glasses previously worn	3	1	11	15
Glasses obtained since working in factory	—	—	8	8
Glasses obtained but *not* worn	—	1	4	5
Probably need glasses	2	3	10	15
Complaining of eye fatigue	—	2	19	21
Apparent eye strain...	3	5	10	18
Conjunctivitis	—	2	11	13
Blepharitis	1	1	2	4
	9	15	75	99

It will be noted that in the Fuze Department 8% of the workers were obliged to obtain glasses since starting factory work, 19% complained of eye strain, of whom 12% found sight difficult on the night shift, and 2% found the eye strain increasing in severity. Besides these, 10% appeared to have latent eye strain as shown by severe headache, blepharitis, &c., and probably required to have their eyes tested. Conjunctivitis was present in 11%. Many workers complained of the artificial light falling directly on their eyes, and others said that the reflection of the brass work of the fuzes was dazzling. The artificial lighting in the factory was by electric lights placed over the benches. Owing to difficulty in train service it was not possible to visit the factory during the night shift in order to watch the effect on the girls, or to observe if shades could be adjusted without undue interference with the work, but this point appeared to need consideration.

On the other hand, it must be remembered that cases of eye strain or frequent headaches may not be due entirely to factory conditions. Several girls had been warned at school by the school medical officer that their sight was defective, and had neglected to obtain glasses. Five workers had obtained glasses but did not wear them; in one instance the previous occupation of dressmaking was probably responsible for the initial eye strain, and in another case a girl who had previously been a domestic servant now visited the cinema three times a week although suffering from marked eye strain. It is also probable that some of the employees were still feeling the effects of overtime and seven days' weekly work, which had recently been discontinued, and some visual improvement might be expected on subsequent examinations.

SUMMARY.

15. It is unfortunately impossible to compare the findings based on the reports from the factories visited with the results of investigations carried out in non-munition factories in time of peace, but they have in themselves considerable interest, and though the numbers are not large they at least show the general physical condition of the women workers in the earlier period of women's labour in munition factories. Factory conditions which were then unsatisfactory have probably been remedied in most cases, means of transit have been improved, canteens provided, welfare supervisors and nurses appointed, unduly long hours reduced, &c., so that the descriptions quoted from the reports do not necessarily hold good now; they serve, however, to indicate the circumstances in which the work was carried out and the discomforts which had to be faced by the women.

The medical findings are on the whole satisfactory. Most of the inspectors had expected to discover far more fatigue directly attributable to the conditions of work, and were agreeably surprised at the general physical condition of the workers. Several suggestions may be put forward as explaining the relative absence of marked fatigue.

In the first place, those who felt fatigue most may have left the factories, and so failed to come under review; indeed, in the re-examination referred to above, only 116 out of the original 210 were present six months later.

In the second place, the dietary was in most cases more ample and suitable than the workers had been used to previously. Wages were higher and more money was spent on food. The women were beginning to realise that they could not do their work unless they had substantial meals, although there was still too great a tendency at the canteens to select pastry, chips, &c., instead of a proper dinner of meat, vegetables and pudding. Food brought from home was often excellent in quantity and quality.

16. Again, although the hours of work were long, they were not usually increased by domestic work at home. Girls in lodgings or living at home were able to pay sufficiently well to be excused from housework, though, indeed, there was usually no time in which this could be performed. A reason sometimes given for not desiring an 8-hour instead of a 12-hour shift was the fact that in the former case the girl would be required to do her share of housework which she escaped with the longer hours. Married women, however, especially when they had young children, frequently found the strain of house and factory work too fatiguing. Further, the factory work, though often monotonous and tedious, was not as a rule particularly exacting and the workers were not putting forth their whole energy all the time. If they had, there would certainly have been far more fatigue observable.

The excitement of doing " war work " and making munitions added a zest and interest to the work which tended to lessen the fatigue experienced, and the courage, perseverance and patriotic spirit exhibited was largely induced by the knowledge that the special efforts made had a common object, namely, to assist the men at the front.

17. Night work proved less exhausting than had been feared (except in the case of married women with children). A fair proportion of girls preferred it to the day shift, partly, perhaps, because of the higher wages earned, and partly because they then gained a little time for recreation or shopping; most seemed able to sleep sufficiently well by day. There were comparatively few indications of nervous irritability, &c., pointing to lack of sleep.

18. But although the results of the inquiry are on the whole encouraging, they certainly emphasise the importance of adequate provision for the health and comfort of the workers. It is probable that as the work continues over a long period and the novelty wears off, the strain will become more serious, the standard of physical efficiency will be lowered and the output consequently decreased unless care is taken to avoid unnecessary burdens and to secure such amelioration as is practicable. The provision of well-managed canteens, for example, is particularly important as the cost of food increases; suitable lodgings or hostels are more needed as factories enlarge and workers are encouraged to come from a distance; hours of work should be restricted within reasonable limits, with sufficient pause at the week-end and with periodical holidays; satisfactory arrangements for transit are essential if unnecessary fatigue and illness are to be avoided, especially during the winter months; properly staffed and equipped ambulance stations and rest rooms are needed where girls temporarily incapacitated by illness or accident may obtain treatment or advice. A welfare supervisor whose duty it is to care for the physical well-being of all women employed, should always be a member of the staff employed by the firm. The provision of day nurseries may sometimes be necessary.

19. If proper care and forethought are exercised there seems no reason why women and girls, suitably selected and supervised, and working under appropriate conditions, should not take their place in munition factories and carry out many operations hitherto considered fit only for men, without permanent detriment to their future health.

JANET M. CAMPBELL, M.D.

LILIAN E. WILSON, M.D.

London: *October*, 1916.

TABLE COMBINING FACTORY, SOCIAL AND MEDICAL

1. Factory.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
2. Manufacture. Processes on which persons examined were employed.	Cartridges and fuzes. Machines, lathes, automatic. Handwork — assembling, and in danger area—filling.	Cartridge and fuze filling. Handwork, danger area—filling, finishing filled cases. machine lathes, automatic.	Cartridges. Light automatic machines.	Cartridges. Machines, automatic, light press, hand work, light bench work, danger area—light machines.	Hand grenades. Machines, lathes, presses, automatic, hand work, light bench work, assembling, &c.
3. Number employed...	955.	475.	2,500.	850.	150.
4. „ examined...	105.	82 ($\frac{3}{4}$ were girls under 18).	149.	210.	130.
5. Conditions in the Factory—	Good.	Good, except insufficiency of lavatory accommodation.	Not good.	Fairly good.	Fair.
(*a*) Sanitation, &c. ...	New, well-built premises, clean, well ventilated.	Mostly new buildings, clean and well ventilated.	Some overcrowding and defective ventilation.	New, well built, except machine shop, ventilation poor.	Old premises, ventilation, &c., fairly good.
(*b*) Feeding	No canteen. Mess room, insufficient cooking stoves.	No canteen. Mess room. Cooking.	Canteen. Fairly good.	Canteen satisfactory.	No canteen, mess room, no cooking.
(*c*) Welfare	No welfare worker.	Matron and assistant, working type.	Matron and assistant.	No welfare work.	Welfare worker, occupier's daughter.
(*d*) First aid	Surgery. 2 nurses.	No surgery. No nurse. Ambulance boxes.	Surgery and 5 nurses.	Surgery and nurse.	Ambulance box in small office at rest room.
6. Means of transit ...	Firm's own vehicles from station, 1½ miles.	Bad. Station 1½ miles distant.	Inadequate trams. Majority spend under 1 hour travelling.	—	—
7. Housing	Majority live at home. Fairly good.	All but 5 lived at home. Semi-rural districts.	Majority live with parents.	—	—
8. Hours of work ...	(1) Day and night shifts = day, 66; night, 64 hours. (2) Day shift + O.T. = 68 hours. (3) 3 eight-hour shifts = 52 hours.	(1) Day and night shifts, 7 days = 61½; 6 nights = 59½. (2) Day shift + O.T. alternate 6 and 7 days = 69—76 hours. (3) 2 shifts, 8 hours, 7 days = 52½—43 hours.	Day and night shifts, 7 days = 67 and 69; night, 63.	(1) Day and night shift (108 women) 7 days = 72; 6 nights = 68 hours. (2) Day shift + O.T. (92 women) 7 days = 77; 6 nights = 68 hours.	(1) Day and night shifts—7 days, 6 nights. (2) Day shift + O.T.
9. Wages	Time rate + war bonus, for 54 hours = under 18 years, 9*s.* 6*d.* to 12*s.*; over 18 years, 17*s.* 3*d.*	Time rate, 2*d.* to 3½*d.* per hour. (Wages raised after arbitration a few weeks later.)	Time and piece rate. Rate per 53 hours, under 18, from 6*s.* to 9*s.*; over 18, from 10*s.* to 12*s.*	Time rate starting for adults at 15*s.*	Piece work. Wages range from 14*s.* to 45*s.*
10. Posture at work ...	Work seated, 72 „ standing, 15 } 105. „ either, 18	Work seated, 47 „ standing, 11 } 82. „ either, 24	Complaints made that sitting was not permitted.	—	—
					MEDICAL
11. Medical classification—	22 per cent. showed symptoms of overstrain.	—	"Large proportion showed signs of fatigue."	—	—
A	59·0 per cent.	61·0 per cent.	65·8 per cent.	61·4 per cent.	50·0 per cent.
B	30·0 „	26·8 „	29·5 „	32·9 „	38·5 „
C	11·0 „	12·2 „	4·7 „	5·7 „	11·5 „
12. Ailments—					
Indigestion	5·7 „	12·2 „	10·7 „	19·0 „	17·7 „
Constipation	11·4 „	12·2 „	25·5 „	18·1 „	10·7 „
Headache (frequent)	2·3 „	8·5 „	6·7 „	25·2 „	31·5 „
Sleeplessness	9·5 „	6·1 „	12·7 „	8·1 „	5·4 „
Muscular pains ..	22·8 „	18·3 „	17·4 „	18·6 „	11·5 „
Anæmia	10·4 „	7·3 „	24·2 „	38·1 „	16·9 „
Disorders of menstruation	14·3 „	12·2 „	12·1 „	22·9 „	4·6 „
Disorders of vision ..	11·4 „	23·0 „	10·7 „	15·2 „	14·6 „
Defective teeth ..	22·8 „	26·8 „	16·8 „	20·6 „	27·7 „

CONDITIONS COMPILED FROM THE REPORTS OF THE INVESTIGATORS.

No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.
Small arms Charges Machines, presses, light automatic machine and hand presses.	Fuzes. Machine lathes—hand-gauging and in danger area, light bench work on loaded fuzes.	Cartridges and fuzes. Machine—automatic machine lathes. Presses—hand work, gauging and examining. Danger area—filling cordite, fulminate, tetryl.	Shells and fuzes. Machines, light automatic.	Shells.	Shells.—machine lathes—hand cleaning, varnishing, &c. (*a*) — (*b*) 900.
120.	1,000.	7,148.	1,604.	70.	
70.	100.	170.	156.	40.	28. 86.
Fair.	Bad.	Fairly good.	Fair.	Good.	Good. Fair.
New factory, all good except no heating yet.	Low standard of cleanliness, ventilation, &c., throughout.	Conditions vary in different sections—not a high level.	Ventilation unsatisfactory.	Ventilation poor.	Good. Ventilation poor.
No canteen. Mess room cooking.	No provision made for meals, no room, no cooking.	Canteens insufficient and unsatisfactory.	No canteen. Mess room, cooking.	Canteen, also mess room and cooking.	Canteen good. Mess room cooking.
Forewoman has some welfare duties.	No welfare worker.	Welfare workers—not satisfactory.	No welfare worker.	No welfare worker.	Majority live near. Majority live near.
No provision made.	No provision made. No nurse.	Surgery and 5 nurses one section, other no provision.	2 surgeries. Ambulance men.	Ambulance box in office.	Good. Good.
—	—	Not good. Majority spend over 1 hour up to 2½ hours.	Good.	—	— Welfare worker.
—	—	—	Fairly good. Live at home.	Fairly good.	Ambulance box. Arrangements poor.
Day and night shifts—6 days = 61½, 5 nights = 52½ (night shift abandoned as unprofitable the week the examination was made).	Day shifts + O.T.—7 days = 77 hours, some cases 80 hours illegally. An easy-going, undisciplined factory, which may account for the long hours not having produced a worse effect.	(1) Day and night shifts—7 days = day, 68; night, 63. (2) 3 shifts, 8 hours—6 days = 48 and 49½.	Day and night shifts—day = 52 hours; night = 55.	Day and night shifts, 6 turns = 63½ hours.	Day shifts and O.T. Sunday = 70¾.
Piece work (no further information).	Piece work + bonus. Danger area, wages 20*s.* to 30*s.* (20 per cent. of those examined). Machine shops 30*s.* to 80*s.*	Time and premium bonus. Rate for 48 hours—16 to 21 years = 9*s.* to 14*s.*, 21 and over = 14*s.*	Piece work, minimum £1 and bonus. Time wage, day £1; night £2.	Time wages from 15*s.* to 28*s.* weekly.	—
—	Work seated, 20. „ standing, 60. „ either, 20.	Complaints—sitting not allowed.	Standing at some machines.	—	Standing at lathes.
RESULTS.					
—	—	Large proportion showed signs of fatigue.	—	—	—
52·9 per cent.	38·0 per cent.	40·0 per cent.	68·6 per cent.	65·0 per cent.	72·8 per cent.
35·7 „	49·0 „	48·2 „	25·6 „	27·5 „	24·6 „
11·4 „	13·0 „	11·8 „	5·8 „	7·5 „	2·6 „
20·0 „	10·0 „	32·3 „	11·5 „	7·5 „	19·3 „
17·1 „	22·0 „	28·2 „	51·9 „	20·0 „	14·9 „
44·3 „	44·0 „	27·1 „	28·2 „	5·0 „	9·6 „
31·4 „	6·0 „	10·0 „	10·3 „	17·5 „	9·6 „
25·7 „	18·0 „	25·9 „	19·8 „	27·5 „	9·6 „
20·0 „	37·0 „	31·2 „	13·4 „	30·0 „	15·8 „
10·0 „	27·0 „	22·9 „	41·7 „	77·5 „	28·9 „
11·4 „	34·0 „	25·9 „	40·4 „	25·0 „	25·4 „
41·4 „	31·0 „	48·2 „	19·2 „	15·0 „	44·7 „

Printed under the authority of His Majesty's Stationery Office
By HARRISON AND SONS,
PRINTERS IN ORDINARY TO HIS MAJESTY,
ST. MARTIN'S LANE, LONDON, W.C.

INDUSTRIAL FATIGUE.

REPORTS ON AN INVESTIGATION OF INDUSTRIAL FATIGUE BY PHYSIOLOGICAL METHODS. By A. F. Stanley Kent, M.A., D.Sc. (Oxon), Henry Overton Wills Professor of Physiology in the University of Bristol.

INTERIM REPORT.—Examination of some Physiological Methods for Investigating Industrial Fatigue; Results of Tests; Criticism of Results. Power of Recovery—Laboratory Workers; Results of Tests—Factory Workers; Summary of Results obtained by the Method of Simple Response and Dilemma; Criticism of the Results Excretory System. *With Charts.*

[Cd. 8056] of Session 1914–16. Price 4½*d.*, post free 5½*d.*

SECOND INTERIM REPORT.—Introductory Letter; Fatigue as a result of Overtime; Influence of Fatigue and o Overtime upon Output; Food and Feeding; Equilibrium and Balancing; Attainment of Maximum Output; Influence of Overtime upon the General Health of the Worker. Appendices:—Details of Individuals examined; Time actually worked in different periods of the day; Index. *With Charts.*

[Cd. 8335] of Session 1916. Price 1*s.* 6*d.*, post free 1*s.* 8½*d.*

FACTORIES AND WORKSHOPS.

ANNUAL REPORT, FOR 1914, OF THE CHIEF INSPECTOR.

Preface. Sanitation. Safety. Employment—Particulars—Truck. Women and Girls in Industry. Emergency Overtime. Regulations—Cotton Cloth Factories, Electricity, Pottery and Other Codes. Industrial Diseases. Results of five years' Notification of Lead Poisoning. Tetrachlorethane Poisoning. Appeals. Statistical Tables.

[Cd. 8051] of Session 1914–16. Price 1*s.* 2*d.*, post free 1*s.* 5*d.*

ANNUAL REPORT FOR 1915.

Deals only with the duties of the Factory Department which have arisen in connection with the War.

[Cd. 8276] of Session 1916. Price 2*d.*, post free 2½*d.*

VENTILATION OF FACTORIES AND WORKSHOPS.

FIRST REPORT OF THE DEPARTMENTAL COMMITTEE.

Deals with General Ventilation for getting rid of Impurities due to presence of employees, and of lights burning. The results of the Examination of the Ventilation of Factories and Workshops visited by the Committee. Conditions on which Efficient Ventilation depends. Method for determining amount of Carbonic Acid in the Air, with diagrams of portable apparatus for estimating the amount.

[Cd. 1302] of Session 1902. Price 1*s.* 8*d.*, post free 2*s.*

SECOND REPORT OF THE DEPARTMENTAL COMMITTEE.

Deals with the Application of Fans to Factory Ventilation, in connection with the Removal of Dust, Fumes, Steam and other Impurities associated with special manufacturing processes; also with the question of Respirators. With illustrations.

[Cd. 3552] of Session 1907. Price 3*d.*, post free 4*d.*

APPENDIX TO SECOND REPORT.

Contains plates and diagrams explaining the results of Experiments carried out by the Committee and illustrating their Recommendations. Experiments on the Construction of Main Ducts and the arrangement of Throats or Branches. Illustrations of Local Ventilation and Removal of Dust by Propeller and Centrifugal Fans, and notes on Practical Construction and use of Ducts, Hoods, and Gratings.

[Cd. 3553] of Session 1907. Price 4*s.* 5*d.*, post free 4*s.* 9*d.*

LIGHTING IN FACTORIES AND WORKSHOPS.

FIRST REPORT OF THE DEPARTMENTAL COMMITTEE.

Vol. I.—Warrant of Appointment. Introduction. Methods of Investigation. Explanation of Technical Terms. Factors in Good Lighting. Existing Requirements as to Lighting. Present Lighting of Factories and Workshops. Causes and Effects of Unsatisfactory Illumination. Recommendations. Conclusion.

The Appendices contain List of Witnesses Examined, and Factories Visited; Circular Letter to Trade Associations; Approximate Number of Persons Employed in the Principal Industries (1907); Summary of Reports received from H.M. Inspectors of Factories; Memorandum on Investigations carried out by the Factory Department, &c.; Requirements as to Lighting of Factories, Schools, &c., in the United Kingdom and in Foreign Countries; Memorandum on Accidents in Factories (with Diagrams); Note on Influence of Lateral Illumination on Visual Acuity; Extract from Professor Snellen's Bowman Lecture (1896); Summary of Replies from Ophthalmologists and Ophthalmic Surgeons to Questions by F. Richardson Cross, F.R.C.S.; Replies to Circular Letter as to Evidence of Injury to Eyesight in certain Trades; Experimental Room at the National Physical Laboratory and some Investigations carried out in it; Summaries of Illumination Measurements in Factories and Workshops; Memorandum on Daylight Illumination; and the Measurement of Illumination.

[Cd. 8000] of Session 1914–16. Price 11*d.*, post free 1*s.* 1½*d.*

Vol. II.—MINUTES OF EVIDENCE. Witnesses Examined. Summary, Précis, and Minutes of Evidence.

[Cd. 8001] of Session 1914–16. Price 1*s.* 7*d.*, post free 2*s.* 1*d.*

Vol. III.—RECORDS OF OBSERVATIONS IN FACTORIES. Introduction: Factory Floors—Textile Industry:—Weaving; Spinning, &c., and Incidental Processes; Lace and Hosiery Making. Engineering Industry:—General Engineering (excluding Foundries); Foundries. Making up of Clothing and similar Work. Miscellaneous Industries. (1915.) Price 7*s.* 6*d.*, post free 7*s.* 11*d.*

MINISTRY OF MUNITIONS.

HEALTH OF MUNITION WORKERS COMMITTEE.

INTERIM REPORT.

INDUSTRIAL EFFICIENCY AND FATIGUE.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1;
37, PETER STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF;
23, FORTH STREET, EDINBURGH;
or from E. PONSONBY, LTD., 116, GRAFTON STREET, DUBLIN;
or from the Agencies in the British Colonies and Dependencies,
the United States of America and other Foreign Countries of
T. FISHER UNWIN, LTD., LONDON, W.C. 2.

1917.

[Cd. 8511.] *Price* 1*s.* 3*d. Net.*